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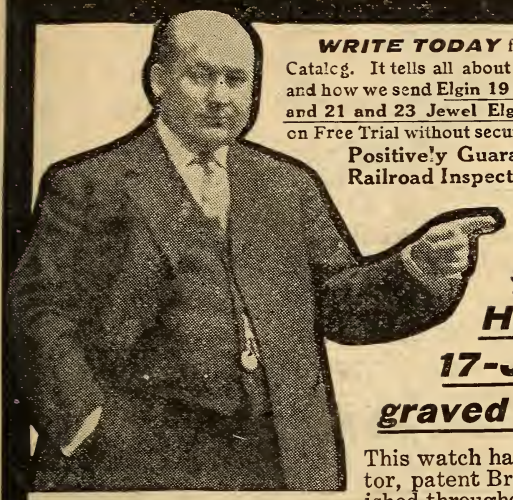

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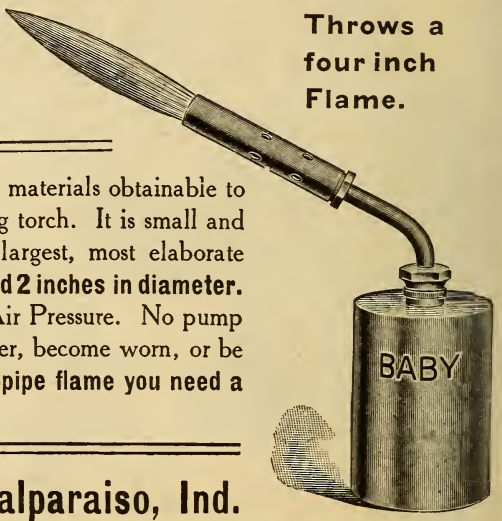

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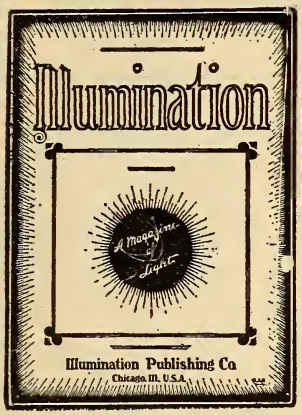

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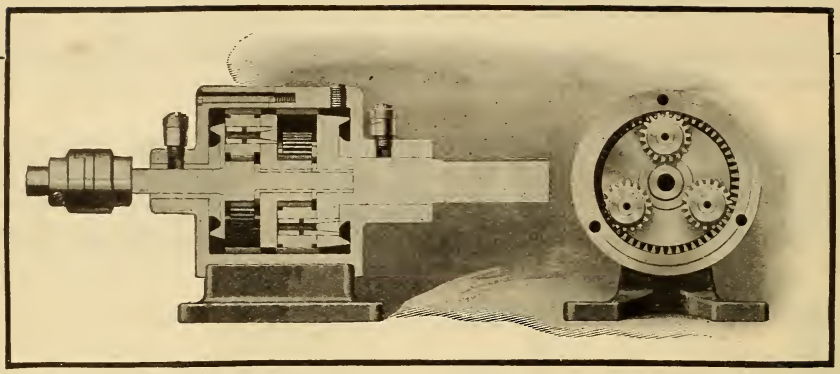

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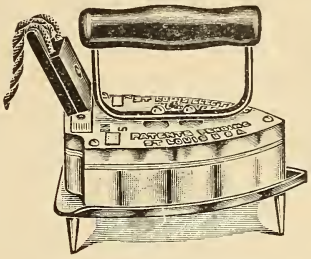

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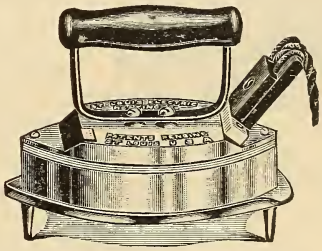

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Don't say you can't afford a heating plant for your home until you GET OUR PRICES. They will surprise you—and we furnish plants in such convenient form that you can INSTALL THEM YOURSELF, if you want to—or have a handy man to do it at day laborer's wages. It costs you nothing to have us make an estimate for you—and we not only save you about 50 per cent in the cost, but we GUARANTEE SATISFACTION. You take no chances. We write it in the contract that our plant will supply the temperature required in each and every room, and hold ourselves in readiness to supply, free of all cost, all materials, should it be needed to bring the plant up to our guarantee. Should the plant at any time within one year prove a failure, or unsatisfactory to you, we will refund the entire purchase price upon the return of the plant to us. We will make you (free) complete working drawings, showing the size of pipes to use at every part of the plant and how to place the fittings, so that you can't go wrong. We will cut all large size pipe for the mains and will lend you an entire outfit of tools to do the work. You cannot get a better plant, even if you pay twice as much. It will pay you to write for our Information Blank. Then give us a sketch showing the arrangement of your rooms, or furnish us with the architect's plans, and we will figure out the exact amount of material needed and our price.

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This is our No. 5 bathroom combination, regularly listed in our catalog for $45. We are making a special offer to readers of Popular Electricity on this of $39. The Bath Tub is 5 ft. long, 30 ins. wide, white porcelain enameled inside and over the rim, and is trimmed complete with full nickel trimmings. The Lavatory is cast iron, heavy white porcelain enameled and trimmed complete with full nickel trimmings. The Closet is high-grade, sanitary, vitreous syphon wash down bowl with polished oak copper lined tank and seat and cover to match. All parts high-grade. **This offer is for a limited time only.** Other Bathroom Outfits from $24.50 to $125.00

$135 Is all it costs for a hot water heating plant for this 5-room cottage, 6 radiators. A total of 215 ft. of radiation and a 400 ft. cast iron sectional heater, together with all the necessary pipe and fittings; radiator valves, gold bronze, covering, and, in fact, every bit of material needed.

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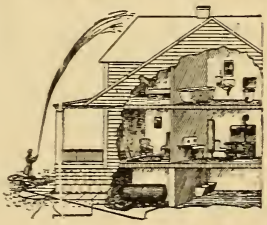

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We will furnish you with a complete pneumatic or air pressure water supply outfit that will furnish you running water the same as city water works. Prices range from $40 upward. We will furnish you complete house plumbing outfit like shown in this picture, including the pneumatic water supply system, the bath room outfit, the kitchen sink and range boiler and all the pipe and pipe fittings to install from $125 upward.

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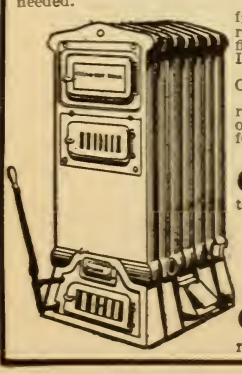
WILLIAM GESSERT, Menominee Falls, Wis.



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I am much pleased with the hot water heating plant, the pneumatic water supply system, the bath room outfit and kitchen sink that I purchased from you for my home. Every part of this plant is thoroughly satisfactory. We have extremely cold winters here; but the heating plant heats the house perfectly. In purchasing this from you, I saved about $400.00.

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POPULAR ELECTRICITY

IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. 11. MAY 1909. No. 1.

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PUBLISHER'S PAGE

INVENTIONS OF EDISON

In this issue Joseph J. O'Brien gives a classification of the inventions of Edison. "Future fame" he says, "will rest largely on the art test, and not on the military test, and by this test Edison is greater than Caesar." Though the truth of this statement may be evident to some, there are many who have very little conception of the great scope of Edison's work. They think of him, perhaps, as the inventor of the electric incandescent lamp or of the phonograph—his greatest productions. But they do not know that his inventive genius has been felt in the fields of photography, glass production, fruit preserving, ore manipulation, electric traction, office appliances and a great many others. In short, Mr. O'Brien's classification shows that Edison's work has extended into 18 groups of main arts under which are 103 sub-divisions of main arts, the total number of separate patents being 858. These figures are astonishing, and the classification altogether makes very interesting reading.

BOUND VOLUMES

Calls for back numbers of the first volume of Popular Electricity have been insistent, although, unfortunately, we have been unable to fill many of the orders owing to the fact that several of the editions have been exhausted. That requests are still coming in for copies as far back as No. 1, Vol. 1 indicates that many are seeking to complete their volumes with a view to binding them up into permanent form for future reference. We are sorry that we cannot comply with all these requests, but we can be of assistance to some who are particularly anxious to preserve complete files, as we have a limited supply of bound volumes containing the first 12 numbers. These will be supplied at a moderate price—first come, first served.

Those who desire a complete index to the first volume may obtain one upon request. Regular subscribers have already received them, but as they were not included in the newstand edition there are no doubt many regular buyers of the magazine who have complete files to which the index will be a valuable addition.

IS EVERYBODY HAPPY?

To make Popular Electricity a magazine interesting and valuable to old people and young people, to the electrical engineer and the layman, in short, to the whole reading public interested in any shape or manner in electricity, has been the aim of its publishers. That success has been found in this attempt is abundantly proven by the mail that comes to this office every day of the year. Here are a few examples:

The president of a large electric light plant in Iowa says: "We have no doubt that after the subscribers get in the habit of taking your magazine they will continue to do so, as there is no question but what it is a good magazine and interesting to the old as well as the young." The secretary of a large telephone company writes: "Personally I value the magazine very highly and wonder that you are able to get so much good information for the money as you are doing." This from a member of an electrical supply company: "Now we have at least ten men, that I know of, in our employ who are subscribers for your magazine, and we consider it one of the best magazines of its kind that we have been able to get hold of."

From the general readers come such expressions as these: "Popular Electricity is the best electrical magazine I ever read; I read quite a number;" "Your magazine I cannot praise too highly. There are so many meaty things on Electricity (on which I am very weak) that touch me in a hungry, tender spot, that I am like the boy with the mixed bag of nuts. Don't know which I like best, all good." "I have just finished reading the January issue of Popular Electricity (the first one I have had the pleasure of reading) and will say that it is the best thing I have ever read on the subject."

RENEWALS: **The date on the wrapper of your magazine shows the issue with which your subscription expires. No additional copies will be mailed after the expiration of a subscription, except upon renewal. Since each issue is printed a month before the date which it bears, renewals should be sent in at least four weeks in advance, in order that no copies be missed.**

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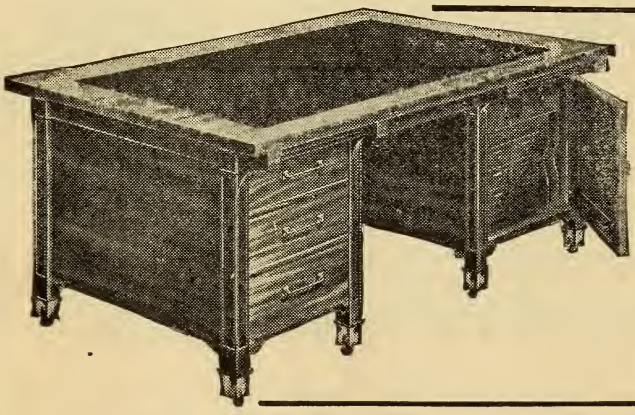

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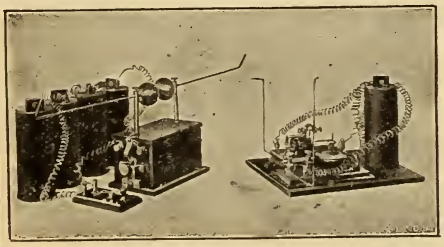

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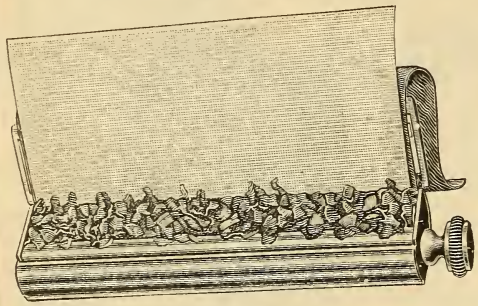

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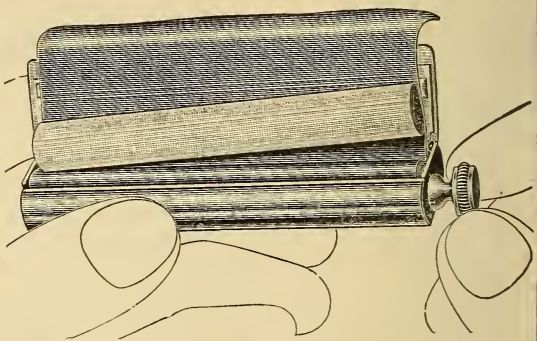

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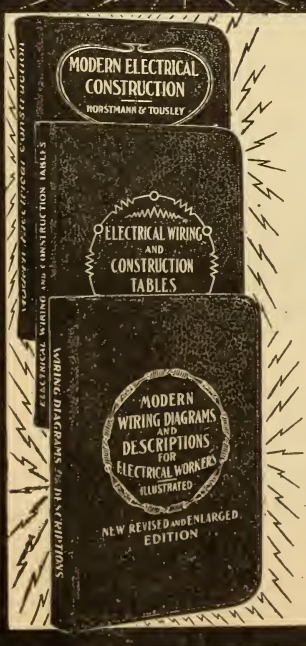
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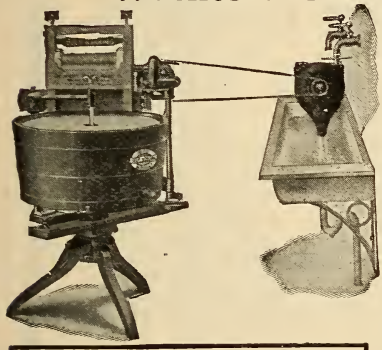

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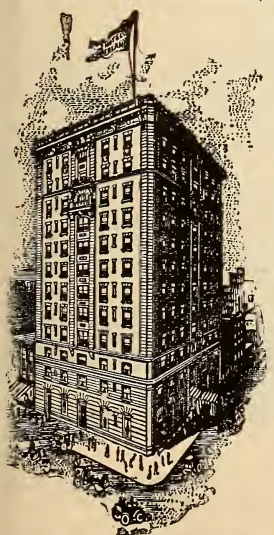

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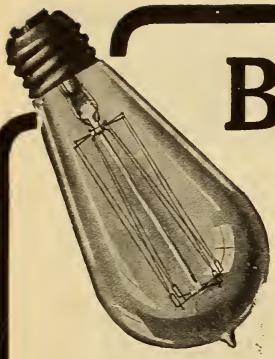

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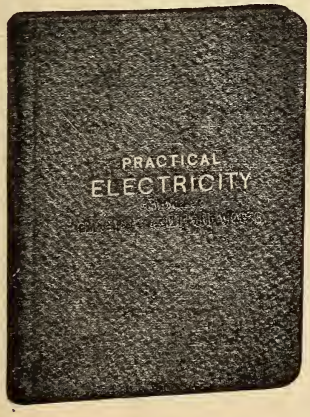

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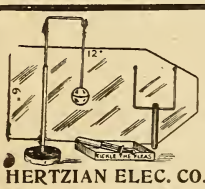

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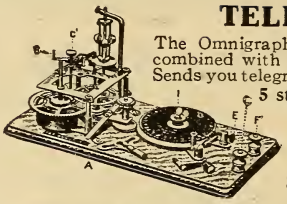

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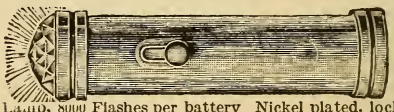

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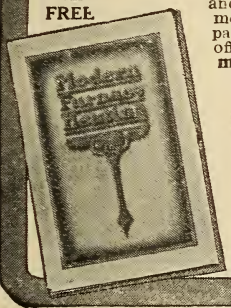

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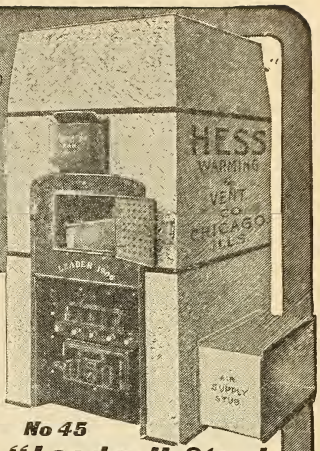

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POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. II MAY 1909 No. 1

HOW SENATORS RIDE TO WORK.

BY WALDON FAWCETT.

The oddest automobile line in the country has recently been placed in operation in the capital city of the nation. Indeed, it is more than this. It may safely be said that it is not only distinctive among all installations of commercial motor cars but is quite the most novel transportation system of any kind in the world. The vehicles that comprise its rolling stock are unique, and finally, it has for passengers the most distinguished body of men that regularly ride on any such semi-public conveyances.

This innovation is an electric motor car line that connects the United States Capitol and the recently completed Office Building of the United States Senate, operating in a subway nearly one-third of a mile in length. In this electric-lighted tunnel are in operation electric automobiles of special design which regularly make the trip from terminal to terminal in one minute or less, carrying ten or eleven of the nation's lawmakers, or friends and constituents who may have business with them.

At present this most up-to-date of motor car lines is in operation only between the Capitol and the Senate Office Building, but it is planned to shortly extend the underground transportation system and have a similar line of cars operating between the halls of Congress and the new Office Building of the House of Representatives, which is located about as far distant from the Capitol as is the Senate Building, but in the opposite direction. The tunnel by which the House of Representatives Building is accessible from the Capitol is a duplicate of the S-shaped "tube" leading to the Senators' working quarters.

Work began several years ago on the two marble office buildings—each costing $3,000,000—for the use of the Senators and Representatives, respectively, these, the largest office structures in the world having been made necessary by the limited amount of space in the Capitol proper, which limitations, taken in conjunction with the constant increase in the number of legislators made it impracticable for more than a fraction of the whole number of Congressmen to have their private offices in the big white-domed building. Almost from the moment that it was decided to build a huge "annex" on either side of the Capitol there was discussion as to the best means of conveying the lawmakers quickly between their office buildings and the Capitol. Obviously an up-to-date system must be devised for it is frequently necessary for Congressmen to make a quick trip in order to vote on a bill upon which a roll-call is demanded or meet other like urgent contingencies.

The first decision reached by Mr. Elliott Woods, Superintendent of the Capitol, was that the various buildings must be connected by tunnel, for, in the vicinity of the Capitol, as elsewhere, Washington is a city of magnificent distances and Capitol Hill is particularly exposed in inclement weather. The tunnel provided, there arose the problem of transportation within the "tube." Various solutions were proposed, including moving

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SIDE VIEW OF ELECTRIC VEHICLE.

sidewalks and miniature electric cars operating on a double-track system. Finally, however, after full investigation the officials gave their preference to a line of automobiles, electrically operated. These traverse a concrete roadway which is of sufficient width for two of the machines to pass at any point in the tunnel. A sidewalk, protected by a heavy iron guard rail, extends the length of the tunnel, parallel to the roadway, and pedestrians may get aboard the motor cars at any point in the tunnel, although it is expected that the autos will not make stops between the terminals except under unusual circumstances.

The motor cars, which derive their propulsive energy from five-horsepower storage batteries, were built for a contemplated speed of 12 miles per hour. It has been found that in actual service the average elapsed time required for a round trip is two minutes. The journey from the Capitol to the Office Building is made in 40 seconds, but nearly twice as much time is consumed in the return trip, owing to the fact that the entire journey is up-grade, and more especially by reason of the circumstance that the cars are, in effect, running backward on the return journey. Owing to the limited space at the terminals and a desire to keep these novel shuttle-cars in continuous operation, the cars are not turned upon completion of each trip. Thanks to the special design of the car with seats along the sides, this mode of operation entails no inconvenience upon the passengers, but when the drive wheels are in front it is more difficult to steer and the chauffeur operates at a slower speed, which, combined with the slight grade, lengthens the time of the journey to the Capitol over that of the trip in the opposite direction.

The exigencies above mentioned were in great measure responsible for the design evolved for these new Capitol motor cars, which are radically different from anything else ever manufactured. To adopt a homely simile, this new style auto might be compared to two dog carts, placed end to end, and linked by a platform on which is the operator's seat, or rather seats, for there have been provided for the chauffeur two individual seats on opposite sides of the car and facing in opposite directions. When the end of a run is reached the driver changes seats and is thus constantly fac-

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END VIEW OF ELECTRIC VEHICLE.

ing to the front, although the machine is not turned around.

Six passengers can be accommodated in the seats at one end of the car and four passengers in the seats at the opposite end. In "rush hours" a passenger can always be accommodated in the vacant operator's seat (if he is content to ride backward) thus bringing the capacity up to eleven, excluding the chauffeur. The bodies of the Capitol autos are finished in a smart tan tint and upholstered with brown leather, a color scheme that was selected as harmonizing with the plastered walls of the tunnel.

The motor cars for the Capitol cost in the neighborhood of $5,000 each, and it is contemplated that eventually four of them will be in operation between the Capitol and the Senate Office Building and probably a greater number between the Capitol and the Representatives' Building, owing to the fact that nearly four hundred Representatives, and an equal number of private secretaries and clerks to the Congressmen must be provided for as regular patrons.

The charging of the batteries of the Capitol motor buses is done at night, and it is not necessary to remove either the vehicles or the batteries from the subway for this purpose, the charging being done at the electric power plant which supplies light, elevator power, etc., to the Capitol and Office Buildings, and which is in the basement on the level of the subway.

FIRE ENGINE WARNING SIGNAL.

Fire engines, as they come rushing out of the barn drawn by half frantic horses, are not easily controlled. They emerge from the doors so suddenly that street cars passing in front of the barn cannot be stopped in time. So sometimes there are collisions.

In order to warn motormen when such danger is liable to occur an ingenious signal is used in Rochester, N. Y., at the corner of Platt and State streets, where there is a fire engine station. The picture shows the signal, which has two vanes. The view is down State Street, while the engine house door is on Platt street, not shown in the picture.

When the fire apparatus leaves the fire engine house the horses run over a contact maker, which is placed in the floor just ahead of the front wheel, and this completes a circuit in the signal box, starting the semaphore arms in rotation. The signal is so timed that it will run for about two minutes continuously, and then stop automatically, thus giving time for the fire apparatus to cross State Street in safety.

Mounted in the end of the semaphore arm are incandescent lamps which show red for night service.

Current for tripping the signal is taken from the 110-volt lighting circuit,

FIRE ENGINE WARNING SIGNAL.

while the current for whirling the signal is taken from the trolley.

Another signal which is installed at Main Street E. and Stillson Street, consists of a device for shutting off the trolley current at some distance on each side of the danger point. It acts on nearly the same principle as a circuit breaker and is contained in a box suspended between the trolley wires. It is tripped by the wheels of the fire-engine, as in the previous case.

ELEMENTARY ELECTRICITY.

BY PROF. EDWIN J. HOUSTON, PH. D. (PRINCETON).

CHAPTER XIII.—THE X-RAYS.

Reference has been made in the preceeding chapter to the fact that by making the portion of the walls of a Crookes' tube against which the cathode rays strike, a thin plate, or, as it was also called *window*, of metallic aluminium, Lenard succeeded in causing some of the cathode rays to pass out of the tube into the air. These rays, called the Lenard rays, are luminous for a short distance from the aluminium window.

Lenard discovered that these rays carry a small charge of negative electricity, possessing the power of causing phosphorescence or fluorescence, as well as affecting a photographic plate. He also showed that they are capable of passing through many substances opaque to ordinary light, and even went so far as to take some faint shadow pictures of opaque or semi-opaque bodies placed on the outside of an aluminium plate that formed the cover of a light-tight box containing a photographic plate. These effects, however, were so feeble that they failed to attract any marked attention. They were produced by Lenard in the year 1894, or considerably after the observations by Plucker, Hittorf, Goldstein and Crookes referred to in the last chapter.

It was not until a later date, 1895, that attention was called to a somewhat similar phenomenon produced in the neighborhood of that portion of a cathode tube against which the rays strike. This discovery, made by Prof. W. C. Röntgen, of Wurtzburg, Bavaria, was regarded by the scientific world as of such importance that its announcement created the greatest excitement, and in a few weeks led to the repetition of the experiments at practically all places that had received information concerning them.

Röntgen had been making some observations on phosphorescence. Knowing the power of the cathode rays to excite this variety of radiation, he had in his laboratory a Crookes' tube through which electric discharges were passing. He had darkened his laboratory; and, in order to prevent the light produced by the Crookes' tube from passing into the room, had carefully covered the outside of the tube with several thicknesses of black paper.

Among some of the substances in which Röntgen had been exciting fluorescence was a sheet of paper covered with a chemical salt known as tungstate of calcium. Happening to place this sheet of paper in the neighborhood of the Crookes' tube, he was greatly surprised to observe that it suddenly began to emit fluorescent light. Assuming, as a matter of course, that the light from the Crookes' tube was escaping through cracks or openings in the black paper, he carefully examined the tube and again arranged its covering until he was convinced that now at least no light could escape. To his surprise, however, the fluorescence of the tungstate-covered paper continued. He was, therefore, forced to the conclusion that there had been produced in the Crookes tube, by the bombardment of the cathode rays against the glass, an entirely new variety of radiation that possessed in a marked degree not only the power of passing through substances ordinarily opaque to light, but after such passage of also producing both fluorescence and phosphorescence, as well as affecting a photographic plate.

For want of a better name Röntgen proposed the name of the X-rays, or the unknown rays, for this peculiar variety of radiation. The selection of this name was in accordance with the usage in algebra of representing an unknown quantity by the letter X. This name, X-rays, has been generally retained in science, although the rays are frequently known, after their inventor, as the Röntgen rays.

It will be observed that unlike the Lenard rays, the X-rays produce no immediate effects on the eyes. If, therefore, an active Crookes' tube were covered with blackened paper, so far as the

sight was concerned, there would be no way in which the presence of the X-rays could be observed by the unassisted eye. If, however, a fluorescent substance were placed in their path, it would immediately become luminous. In a similar manner a photographic plate is also instantly affected.

As already remarked, the cathode rays are not produced until a certain high vacuum is reached. The additional discovery was made shortly afterwards that when this high vacuum exceeded a certain value, the amount of X-radiation produced was greatly decreased.

It may occasion some surprise that Lenard's discovery of rays that were able to pass through substances opaque to light and produce fluorescence, phosphorescence and photographic effects, so signally failed to arouse the attention of scientific men as was occasioned by Röntgen's discovery. There was, however, this difference. Lenard discovered an effect, so faint in its intensity that it could only be observed in the immediate neighborhood of the aluminium window. It was therefore without any practical value. Röntgen's discovery, on the contrary, was of a radiation of such intensity in its penetrating power, that it was capable of producing its curious effects at considerable distances from its source.

When Röntgen demonstrated that the X-rays possessed such penetrating power that they could readily pass through inch boards of wood, a thousand pages of an ordinary book, or two packs of playing cards, and still be able to produce fluorescence, phosphorescence, or photographic effects, it is not surprising that the announcement instantly commanded the close attention of the entire scientific world. Not only because there was something apparently uncanny in the ability to see what was otherwise invisible, but especially because in addition to this, it was found that the X-rays possessed the wonderful power of readily passing through the flesh, blood and soft tissues of the human body, so as to permit its bony skeleton as well as some of its internal organs to be examined. The world at large recognized that these rays would afford a wonderful aid in medical diagnosis. Therefore the discovery attracted universal attention.

Suppose, for example, as represented in Fig. 86, that a screen consisting of a sheet of paper or other substance transparent to X-rays, covered with a fluorescent substance, such as tungstate of calcium, or platino-barium-cyanide, is placed at the larger end of a stereoscope with the fluorescent surface turned towards the inside. Then if one hand of the experimentor is held outside the box near the fluorescing plate, or as it is called the fluorescent screen, and his eyes placed at the opening in the smaller end, a picture will be seen on the screen of the bones or other opaque integuments of the hand when X-rays are permitted to fall on the outside of the hand

In a similar manner, if, as represented in Fig. 87, X-rays are passed in a nearly dark room through the human body as represented, and a large screen covered with a fluorescent substance is placed near the back of the person standing in front of the source of X-rays, there will be seen on the screen, the fluorescent surface of which is turned from the body, a shadow picture of its skeleton and other semi-opaque parts.

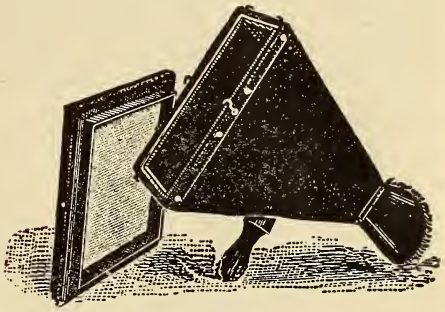


FIG. 86. PLATINO-BARIUM-CYANIDE SCREEN.

In this picture the X-ray tube is shown with the X-radiation thrown from one-half of its surface, and its terminals connected with the terminals of an electro-static induction machine provided with Leyden-jar condensers.

The fluorescent pictures above referred to exist only while the rays are passing. It is easy, however, to produce permanent pictures. To do this it is only necessary to employ a sensitive photographic plate, wrapped with several

thicknesses of blackened paper so as to be thoroughly opaque to ordinary light and placed on a table with its sensitive surface upward below an excited X-ray tube, as shown in Fig. 88, so that the rays may fall freely on the paper. Before the current is passed through the tube the hand is placed as shown on the paper, between the sensitive surface of the plate and the X-ray tube. Under these circumstances, only those portions of the plate are affected where the rays pass freely through the flesh, blood and other transparent tissues, while the bones, and other opaque or semi-opaque tissues cast shadows on the plate. Consequently, the negative so produced is employed for printing a picture. Such a picture of the foot and shoe is seen in Fig. 89.

It will readily be understood how great an aid an X-ray photograph, like the above, would afford a surgeon in locating the presence of a foreign body like a pistol ball, a needle, pin, or other body, that had been accidentally introduced below the surface.

In the above example, the high-pressure electric source employed for the operation of the X-ray tube is a Ruhmkorff induction coil capable of producing a 15-inch spark through free air.

The intensity of the effects produced by X-rays varies not only with the character of the vacuum in the X-ray tube, but also with the intensity of the electric discharge. If, however, too great a bombardment of the cathode rays is permitted to fall against the wall of the tube, the glass may be rapidly melted, thus destroying the tube. In order to avoid this, instead of permitting the cathode rays to fall directly on the wall of the glass tube they are caused to strike against a piece of highly refractory metal such as platinum, placed opposite the cathode. Such a piece of metal is called an anti-cathode, and can

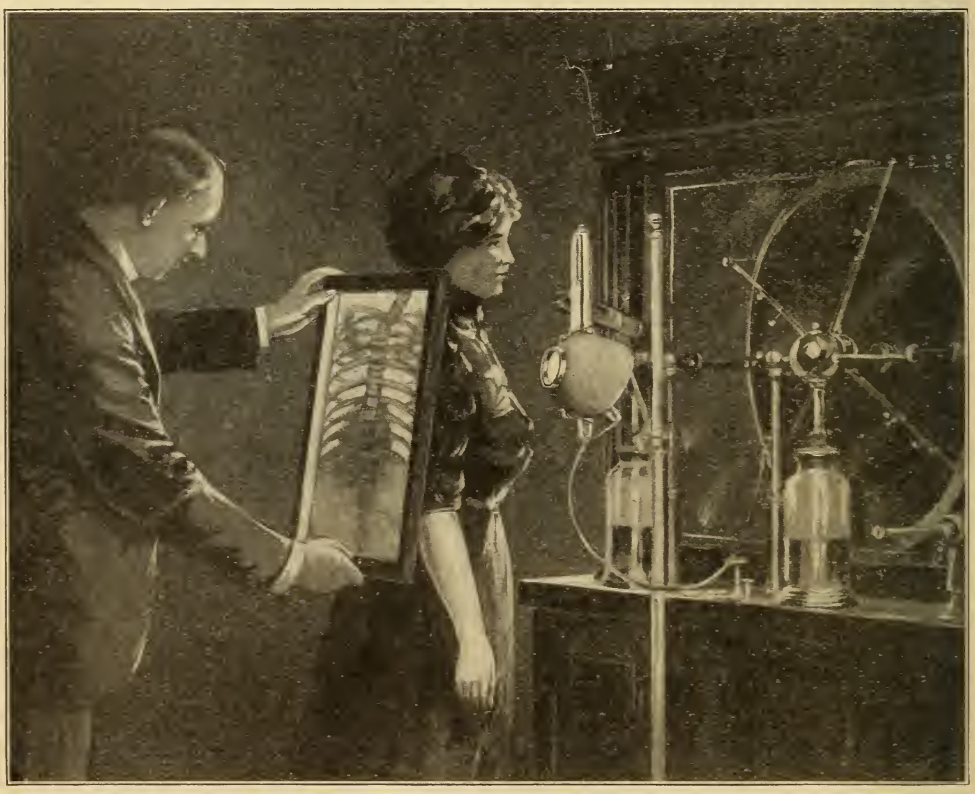


FIG. 87. AN X-RAY SHADOW PICTURE.

safely be exposed to a bombardment that is capable of raising its temperature to incandescence. An X-ray tube provided with an anti-cathode contains also a cup-shaped terminal that focuses the rays on a point on the surface of the anti-cathode, thus insuring a sharper shadow picture than if the X-rays were thrown off from an extended surface.

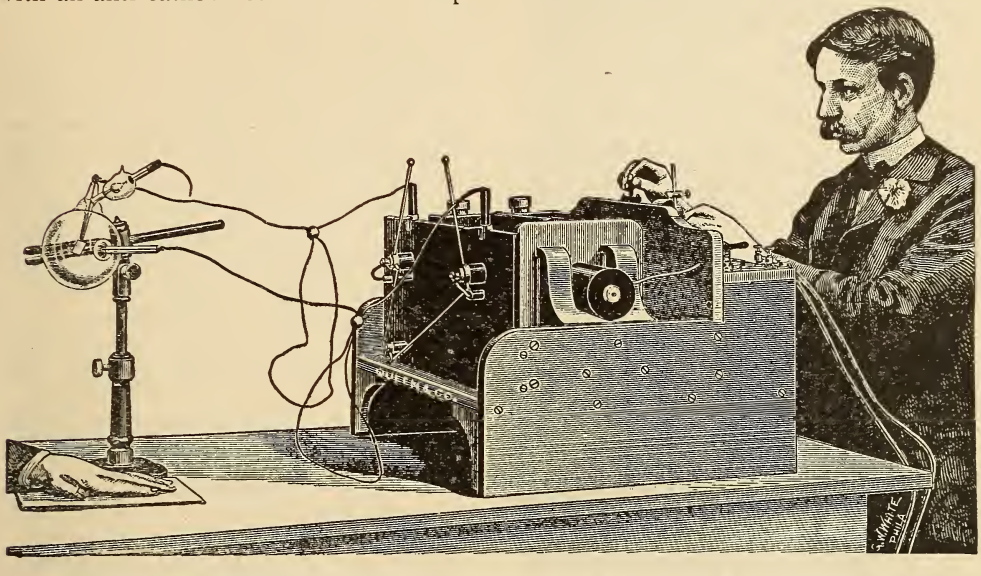


FIG. 88. TAKING A RADIOGRAPH OR X-RAY PICTURE OF THE HAND.

Various forms have been given to X-ray tubes. In some, arrangements are provided whereby the extent of the vacuum may be regulated, thus permitting the most effective vacuum to be readily obtained; for, it can be shown that after a somewhat prolonged use the vacuum in the tube increases to such an extent as to render it practically inoperative unless a gradual leakage may occur into the tube.

The Queen self-regulating X-ray tube represented in Fig. 90, is suitable only for use with the currents like those obtained from an induction coil or a static induction machine. In consists of a large bulb (B) that forms the X-ray tube proper, and a smaller bulb (D) communicating with (B), so arranged that it can automatically lower the vacuum in (B) should it become too high to produce X-rays. The construction and operation of the self-regulating X-ray tube are as follows:

The X-ray tube proper (B) is provided with a cathode (C) composed of hammered aluminium in the form of a concave reflector of such dimensions that the cathode stream is focused on the anti-cathode (A) or anode formed of platinum. The outer end of the cathode is represented at (K).

(B) is exhausted to such a high vacuum that initially no discharge will pass

FIG. 89. A RADIOGRAPH OR X-RAY PICTURE.

through it. The bulb (D) on the contrary, is exhausted to a low Crookes vacuum. A small pear-shaped bulb (X) communicates with the bulb (B) and contains a chemical substance capable of giving off a vapor when heated, and reabsorbing it when cooled. A small cathode is placed in bulb (D), so placed that a discharge from this cathode will heat the bulb (X). An adjustable spark point (P), is so arranged that its further end can be swung to any desired

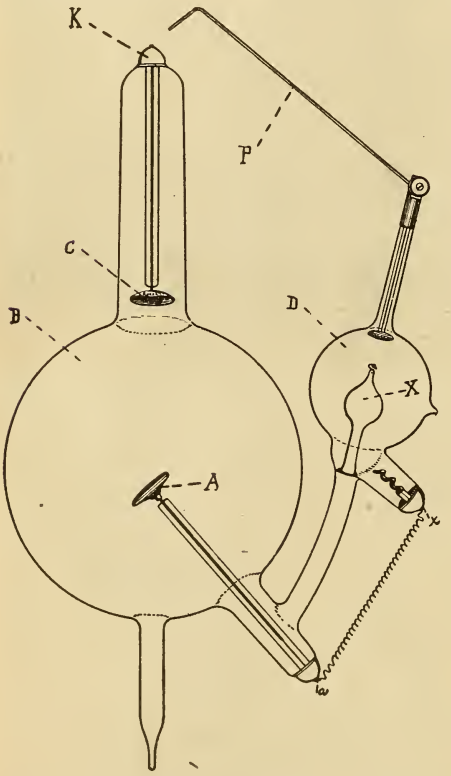


FIG. 90. QUEEN SELF-REGULATING X-RAY TUBE.

distance from the terminal of the main cathode (C) at (K).

When the self-regulating tube is first employed the discharge cannot pass through the bulb (B), on account of its high vacuum, but readily passes from (K) to (P) through the bulb (D). Heating the bulb (X) it causes vapor to be given off from the substance it contains. This vapor entering the main bulb (B), lowers its vacuum so as to permit the cathode rays to be discharged from the cathode (C), which falling on the anti-cathode (A) cause it to become a source of X-rays.

The exact nature of the X-rays is unknown. There would appear to be little or no doubt that as stated in the last chapter by J. J. Thomson, the cathode rays by which both the Lenard and the X-rays are produced consist of minute fragments together with larger fragments that are torn off from the cathode by the electric discharge and that these particles carry with them charges of negative electricity. If this is so it would seem improbable that any but the very small particles could find their way through those portions of the glass walls of the tube against which the cathode rays fall. Since, however, this will be more fully explained in the chapter on radio-activity, a further explanation will be deferred as to the character of the X-rays until then.

X-rays differ greatly in their penetrating power according to the condition of the vacuum of the X-ray tube and the electric pressure employed for its operation. The penetrating power, however, and the ability to produce X-ray photographs, will vary with the distance from the tube. Neglecting losses by absorption provided they are produced from a point source, the penetrating power will be inversely as the square of the distance.

The most sharply defined X-ray photographs are produced when the rays come from a point rather than from a surface.

As regards the character of the sensitized plate employed in X-ray photography, it has been found that certain emulsions are especially sensitive to this form of radiation, so that the best results are obtained by the use of plates especially prepared for the purpose.

Care must be taken to avoid too prolonged an exposure of the body to an active X-ray tube for this character of radiation, like sunlight, possesses the power of setting up a severe inflammation that may result in suppuration and sloughing of the tissues. A curious difference, however, exists between the position of the parts affected by sunburn, the name given to such inflammations when caused by sunlight, and X-ray

burns or dermatitis, or that caused by exposure to X-rays. Sunburns are limited to the outer surface of the body. X-ray burns affect principally a portion of the surface of the bones called the periosteum. This is to be expected, since the flesh and other tissues covering the bones permit the X-rays to readily pass through them, and fall almost as freely on the bones as if all the flesh and blood had been removed, and the bones were directly exposed to the radiation.

X-ray burns are often exceedingly severe, and may necessitate the removal of an arm, or a leg, or even cause death. What makes it all the more difficult to avoid such burns is the fact that a comparatively long time generally elapses between the exposure and the setting in of the inflammation. For example, several weeks may elapse before the inflammation shows itself. With proper care, however, X-ray examinations and X-ray photographs can be made by comparatively short exposures, so that no serious results to the patient need occur. It is different, however, with the operator, who is apt to suffer severely from overexposure. When, however, care is taken to protect the body by shields of lead plates, and to avoid unnecessary exposure to direct radiation from the X-ray tube, no serious results need occur.

(To be continued.)

STRIKING ELECTRIC SIGN.

The electric coffee sign shown in the picture is so realistic that it would almost give you a thirst, so to speak. The sign is 21 feet wide and 32 feet high, and is erected on a prominent corner in Atlanta, Ga.

The border is outlined by three rows of lights—red, white and green—the colors changing about 20 times a minute. The immense letters of the wording, "Luzianne Coffee" have also three rows of lights, red, white and green, and, together with the border, are flashed consecutively red, white and green, and then all colors at once. Lights in the remainder of the lettering are all white and burn continuously.

The picture on the sign represents an ante-bellum "Mammy" pouring her coffee and a bank of lamps are so arranged and operated by flasher, that the steam which is continually arising from the cup and pot gives a beautiful cloud effect, while the stream of coffee being poured from the pot is plainly visible. The sign contains 1,350 two-candlepower incandescent lamps.

STRIKING ELECTRIC SIGN.

ELECTRIC SWINGING DOOR.

Revolving doors leading into the Hotel Astor in New York are now operated by electricity instead of by hand. A doorman whose duty it used to be to swing the glass doors by main strength, now does his work with no greater exertion than is needed to press a button.

He stands in the hotel lobby some distance from the doors. In his hand he holds an electric button attached to a wire. The other end of the wire is connected with the door swinging apparatus. When anybody approaches the doors from either the street or the lobby side the doorman presses the button and the doors swing round.

GASOLINE CARS SUPPLANTED BY ELECTRICITY.

There is an interurban railway 20 miles in length extending from Kansas City, Mo., in a southwesterly direction to Olathe, Kan., that is of more than usual interest from the fact that it affords an example of the abandonment of the gasoline-operated motor cars, which attracted considerable attention a few years ago, in favor of the straight overhead electric trolley system. For several years the road was operated with the gas-electric system of motive power, in which each motor car is a complete power station, with gasoline engines driving electric generators, supplying, in turn, electricity to operate the motors. But it was decided, after careful consideration, that the straight electric system offered advantages in economy, attractiveness to the public and reliability of operation, and so the road was "electrified," the electric service going into operation the first of this year.

No unusual conditions presented themselves in planning and building the electrical equipment. The line extends from the intersection of Thirty-ninth Street

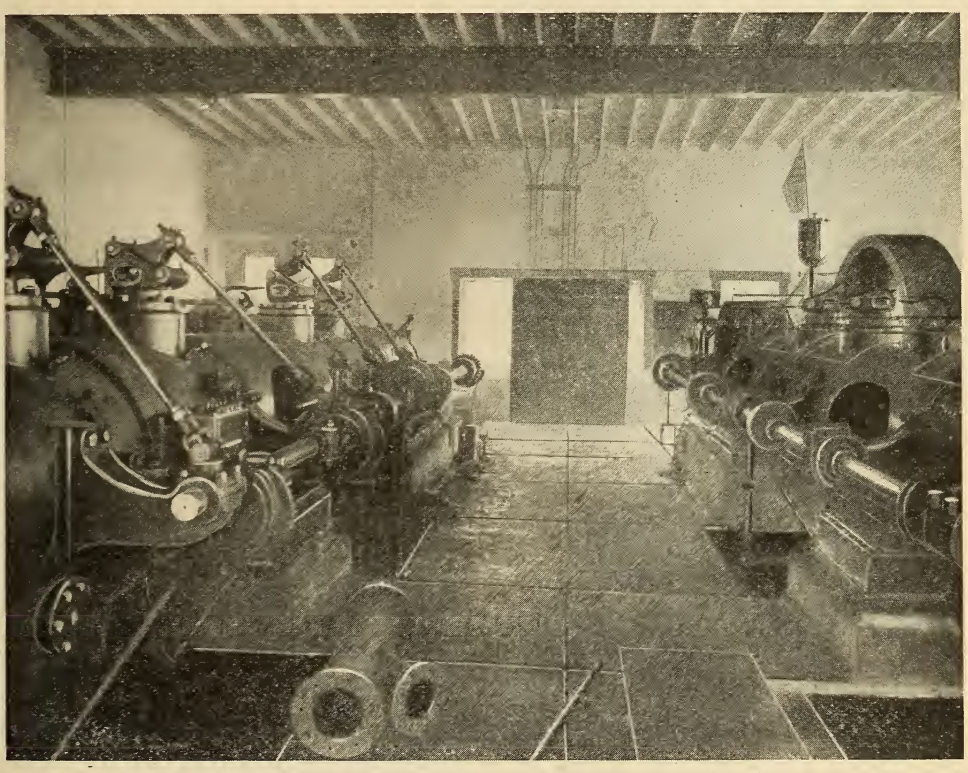
MISSOURI AND KANSAS INTERURBAN RAILWAY CAR.

POWER HOUSE OF THE MISSOURI AND KANSAS INTERURBAN RAILWAY.

and the state line in Kansas City, where it is connected with the local street railway system, along a ridge known as the Old Santa Fe Trail, through the villages of Overland Park and Lenexa to Olathe. There are no bridges and no grades steeper than 1½ in 100, except at a hill near Olathe, where the grade is 4 or 5 in 100. The tracks of the Missouri and Kansas Interurban Railway Company, which built the road, are laid on private right-of-way exclusively, with 70-pound rails and white-oak ties.

The ordinary 600-volt direct-current system is used. Power is supplied to the line by a power station at Overland Park, about seven miles from Kansas City. Electricity is generated by two dynamos of 260 horsepower each, driven by gas engines direct coupled. The gas supply is obtained from gas wells on the company's property, and there is also a connection with the mains of the company furnishing power gas to Kansas City. The electricity is fed directly into the overhead trolley wire, without "feeders," which are usually employed in electric railway work. This wire is of copper and is of the size known as No. 0000. It is suspended from brackets on poles on the tangents or straight stretches of track, but on curves the cross-suspension system is used; that is, poles on each side of the track support cross wires, to which the trolley wires are attached.

As the power house is about thirteen miles from the Olathe end of the line, there is a considerable "drop" in the electromotive force or electrical pressure. Owing to the considerable current used and the comparatively low pressure at the start, the 600 or 625 volts at the power house is not more than about 440 volts at the end of the line, the loss being represented by energy consumed in overcoming the resistance of the large copper wire for this distance. And it is just at this point, too, that the voltage should be at its highest in order that the motors may work at their greatest efficiency in climbing the



GAS ENGINES FOR DRIVING RAILWAY DYNAMOS.

hill. It may be explained that the power plant was not placed at the midpoint of the line because the car-barns were located on the company's property at Overland Park in the time of the gasoline cars.

To overcome this "drop" a storage-battery station is in operation near the Olathe end of the line. This is arranged to "float" on the line, as the engineers express it. The line pressure, 440 volts, is used to charge the battery, which is discharged as needed at 600 volts. Of course, as something can not be made out of nothing, the voltage is "boosted" at the expense of some current, but as amperes are plentiful and volts are what are needed, the arrangement is entirely satisfactory.

Prominently shown in the exterior picture of the power house and car barns at Overland Park is an elevated water tank. This is part of the water-supply system. A motor-driven pump forces water from a spring about 2,000 feet distant up into the tank, whence the water is distributed about the plant as needed. The gas engines in the power plant are water-jacketed to keep them cool, and from this tank the circulating water is obtained.

The passenger cars used on this line are large and handsome. They are 44½ feet long and will seat 52 persons, 12 in the smoking compartment. Four 40-horsepower motors, on two trucks, propel each car. The cars are designed to operate in one direction only, and the motorman's cab is arranged at one side of the front end of the car. This gives passengers a practically unobstructed view through the front of the car, at the same time securing maximum seating capacity and a front exit.

From the Kansas City terminal the cars are operated for a distance of about three miles to the center of the city by the Metropolitan Street Railway Company of Kansas City. The business of the interurban road has been greatly increased since the electrification.

EXPERIMENTS WITH HIGH-VOLTAGE CURRENT.

BY H. L. TRANSTROM.

Two different effects are produced at the terminals of a high-voltage transformer which are very interesting to study. In the first illustration, the discharge resembles a flame as from a burning match but much larger.

When the terminals are charged to the full voltage, and the discharge is not allowed to pass, it is called static, meaning that the charge is in a state of rest. The voltage is then at the maximum, but as soon as the pressure breaks down the high resistance of the air, the air is heated to incandescence which lowers its resistance to a few ohms. The voltage correspondingly decreases to a fraction of the voltage which existed before the resistance of the air-gap was broken down. The flame is very hot and assumes a yellow color because of the presence of sodium in the air. If the terminals are composed of copper the flame is bluish and the cotton covering gives it a reddish tinge.

The characteristic inverted V-shape of alternating discharges of a high voltage transformer is due to the heating of the particles of air which causes them to rise, drawing the flame upwards to a height of several inches, depending on the voltage, amount of current flowing and the shape of the terminals. The "horn" lightning arrester is based on this principle, two terminals of heavy copper wire being set quite close together at the bottom but spread apart at the top so that the draft of air blows out any arc that may form by the line current after the lightning has passed through it to the ground.

If a condenser, such as a leyden-jar or any high voltage condenser is shunted across the terminals, the flame discharge ceases and assumes a more startling form. The flame discharge is practically noiseless and gives a very ordinary light, but the condenser discharge produces a roar like a miniature thunder clap and yields a dazzling light very much like lightning. To the eye each discharge appears to be a single spark, but it has been proved, when analyzed

by a very rapid picture taking device, that it is made up of several sparks alternating with almost inconceivable rapidity.

To understand this consider the action of the pendulum. When given its initial energy, necessary to raise it to one side a certain height, and then released, it drops to its position when at rest but does not stop there because of its inertia, swinging to a height almost as great in the opposite direction and then back and forth, each succeeding swing a little shorter than the one preceding until it comes to rest at a vertical position. The reason it comes to rest is that the friction of the pivot and the air resist its motion, otherwise it would continue to swing indefinitely.

The electrical inertia is vastly greater than the inertia of the pendulum, so when the condenser surfaces are given their initial charge from the secondary of the transformer, they discharge through the high resistance air gap, from the positive

CHARACTERISTIC V-SHAPED DISCHARGE.

plate to the negative. The former, because of its inertia, overdischarges and causes the negative to become positive and the positive, negative. If the air gap is not too long the plates will again discharge only in the opposite direction, repeating this until the charge cannot bridge the air gap. Each discharge is a little weaker than the one preceding, as were the strokes of the pendulum, due to the loss of energy dissipated by the light, heat and sound.

DISCHARGE WITH CONDENSER ACROSS TERMINALS.

The longer the pendulum the less frequently will it swing, and the larger the capacity of the condenser, the less the frequency of the discharges, therefore a small condenser gives a higher frequency than a large one.

When one charge has been dissipated in the spark the transformer again charges the plates to a high voltage and the discharge is repeated.

If the condenser is small enough and the air-gap through which the spark jumps short enough, the condenser can be charged and discharged several times during one alternation of the transformer. If the discharge of the condenser is permitted to pass through a suitable coil of wire in series with the spark gap and a secondary of suitable construction is placed in a proper position to it, we have what constitutes a Tesla coil and induced high frequency current.

EARLY ELECTRIC LOCOMOTIVE.

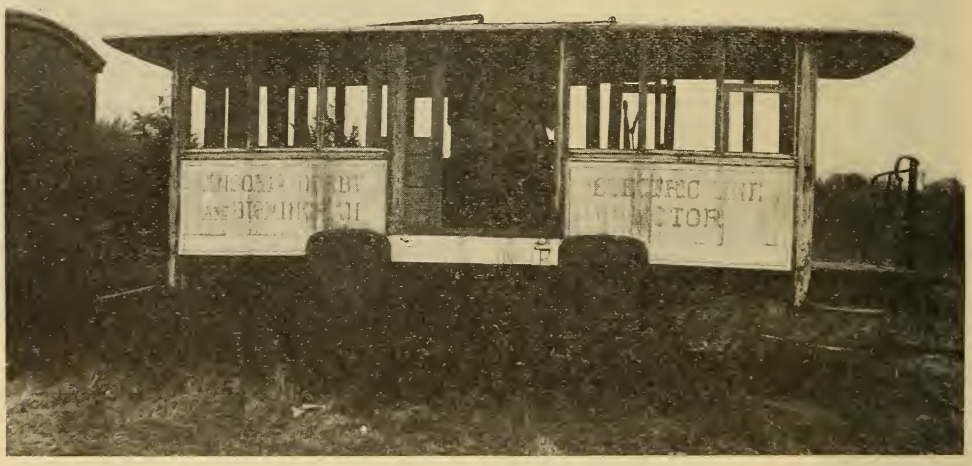
One of the first electric locomotives put in operation for commercial purposes is shown in the picture. It was constructed in Wisconsin and shipped to Derby, Conn., and there put into immediate use for the hauling of freight between the towns of Ansonia and Derby, and was the only means of hauling freight or expressage from the busy manufacturing town of Ansonia to the Derby docks, the marine shipping point for the Naugatuck Valley.

The Naugatuck Valley Steamboat Company used to ply between the cities of New York and Derby, furnishing means for conveying freight between the manufacturing towns of the valley and all commercial points, and this freight was hauled by trucks drawn by horses until electric transportation was installed.

The motor car was among the first of its kind to be built, and the motor was constructed very clumsily, occupying a large portion of the car. The remaining space was devoted to the controlling apparatus, brakes, etc. The motor car and trailers were constructed very low, owing to the necessity of passing beneath some low bridges or trestles; and this made it impossible to stand erect in them. The first run was made on the morning of April 30, 1888, from Ansonia to Derby.

Soon after the freight service was inaugurated it was found that the railway company could operate passenger service to replace the horse cars that were plying between Birmingham (now Derby), East Derby and Ansonia, so they had a car constructed of a somewhat similar design to that of the freight service, only the motor was mounted in one end of the car, and the rear was used for passengers. To the motor shaft was attached a union, meshing into a large gear; this gear was mounted upon a steel counter shaft, carried by broad bearings solidly attached to the bottom of the motor, so that the center of the motor shaft was always true with the counter shaft. Attached to this were two sprocket wheels which in turn were connected to two sprockets of larger dimensions and attached to the front axle, the means of propulsion being a steel chain between the sprockets. The motors were of 15 horsepower and the cars would run about 40 miles an hour on level ground.

One of these historical motor cars, as shown in the illustration, is now on exhibition at Pine Rock Park, Connecticut.



EARLY ELECTRIC LOCOMOTIVE.

THE TUNGSTOLIER.

The tungsten lamp is here to stay for the simple reason that it gives a near approach to sunlight at a current consumption of 1¼ watts per candlepower. But the lamps cannot be put up in a haphazard manner. Some have tried to do this to their sorrow. They have taken old-fashioned fixtures and tried to shorten them and hammer them into shape to fit the requirements of the new lamp, with the result that the final cost has been greater than to have installed suitable fixtures at the start.

The principal requirements necessary to obtain the most efficient service from tungsten lamps are prismatic reflectors properly to diffuse and distribute the powerful light; a properly designed fixture to carry the lamps and reflectors, and a simply and substantially constructed link to suspend the lamp in a vertically downward position, which is the way a tungsten should hang. These requirements are very well attained in the "tungstolier," an example of which is shown in the picture. The particular type illustrated is what is known as the folding tungstolier, that is, its arms work on hinges and may be closed up like an umbrella. It may therefore be shipped and stored in a small, compact package. When it is put into service its arms project outward and give a firm and rigid support. The sockets for the lamps, which also carry the shades, are then hung to the arms. The fixture comes already wired, it being only necessary to connect the wires in the stem to the outlet wires and to fasten it to the ceiling.

THE TUNGSTOLIER.

There are more than seven million telephones in regular service in this country and during the past year more than 7,500,000,000 messages were sent over the wires.

TRAINING A FIRST-AID CORPS.

How many men know how to act when a live wire is sizzling and sputtering around the sidewalk? Who among us could jump to the rescue of some unfortunate who has stepped on a current-carrying third rail? Neither live wire or still more lively rail are likely to suspend business while an expert is sent for, and it is someone's duty to act quickly in such an emergency if lives are to be saved. But saving another's life at the expense of one's own is a sacrifice that does not appeal to the average citizen and visions of sudden death by the method that is becoming the popular one for sending murderers to the great beyond are disturbing factors to the greatest hero among the spectators of an electrical horror.

The demon of the dynamo, however, loses much of his power to paralyze would-be rescuers when knowledge steps in to point the way to safe as well as quick action in rescuing victims of such accidents. This is regarded by the directors of our great railway systems as so self-evident a fact that concerted steps are now being taken to establish a national society of first aid to electrical victims. It is hoped that the work now in progress will in time become so widespread that never will a live wire get loose on one of its rampages or the third rail grip an unsuspecting wanderer in the forbidden paths of our railway lines without some bystander having sense and presence of mind sufficient to do the right thing at the right moment and with sufficient celerity to effect a rescue.

The work has been progressing so quietly that few are aware that this new "first aid" movement is in progress. The

HOW TO REMOVE A VICTIM FROM CONTACT WITH A CHARGED WIRE OR THIRD RAIL.

railways have had expert lecturers going the rounds of work shops and yards, gathering the men in their dinner hour or whenever there is a good chance for an audience and teaching them systematically how to deal with electrical accident cases.

One of the first lessons imparted, naturally, is how to tear the victim of a live wire or third rail accident from the clutch of the terror that lives in the metal. To take the live wire first: The men are taught that the way to detach this wire from the body of the man who has been shocked into helpless unconsciousness is for two of the bystanders to pull off their coats and twist them into a rope. One coat will do if the job of making a rope of two is likely to take too long. The two men run to the scene of the accident, holding between them the rope of coats. Passing this over the wire they can pull it away from the man on the ground without receiving any shock themselves. While they hold the wire away the victim can be dragged from the scene of danger. The coat idea is only advanced because a coat is the handiest thing to use. There is no time to run for a rope. A man can peel his coat off in a second, and having learned the lesson it will occur to him to do this at the first intimation of the need of a rescue.

In the third rail accident the men are told that if they will approach the victim with some caution and grasp him by the slack of his coat he can be dragged from the deadly rail without danger to the rescuer. Or he can be pried from the embrace of the current that is taking his life by means of a wooden bar or any piece of wood that is long enough for the purpose.

It is assumed by the lecturers that the victim will fall across the rail, for almost all third-rail accidents happen this way. A man stepping on the rail drops like a log and naturally drops right into the jaws of death. Now it does not follow that third rail contact kills at the first shock. The voltage is not sufficient to instantly render lifeless a strong and healthy man. It will kill a weak man, in all probability, at the first shock, but even in his case there is a possibility that

METHODS EMPLOYED IN RESUSCITATION FROM ELECTRIC SHOCK.

quick action may save him. In the past the unlucky individual wo has stepped on this concealed death trap has remained there to be shocked to death. In the future it is hoped there will be some "first aid" expert at hand to prevent such a calamity.

The methods to be used in rescuing victims of electrical accidents are not all that is taught at these first aid lectures. The men are instructed how to go to work when the unconscious man or woman lies prone and still and apparently lifeless. Quick treatment in such cases is as necessary as it is when some swimmer has been dragged unconscious from the waves.

Some of the accompanying pictures, showing a lecture in progress, illustrate the methods of treatment very plainly. The patient is first placed on his back with a coat under his shoulders to permit the head to fall back. His clothing is loosened at the neck and his sleeves and trousers rolled up. While one man is doing this another is examining the man's mouth to see if the tobaccco he may have been chewing at the time of the accident has not slipped down his throat, or his false teeth, if he wears them, are not choking him. If ice is handy this is rubbed on the spine.

Another man during this time can be moving the arms of the patient in the proper way to restore respiration. The arms are brought from the side of the chest to a line straight with the body until they meet over the head. Then they are brought sharply down again. The next movement is to bring the arms in a straight line to the side of the walls of the chest. Then they are pressed over the lower ribs to expel the air drawn in by the previous operations.

An additional lesson, one that has no connection with the saving of life, but which is important to the men who work where live wires are, is the teaching of the use of a hose during a fire.

Many of the men who work in the danger zone know that when a fire breaks out there is not only the risk of contact with broken live wires to be feared, but that the mere playing of a hose on a live wire will give a man a shock that is far from pleasant, to say the least. The men are taught during the lectures how closely they can approach with a hose the vicinity of a live wire. At a distance of seven feet five inches the current from a live wire has not enough power to harm a man who is at the end of a hose from which water is pouring on the wire. If he approaches cautiously he can come within two feet of the wire with the hose pipe without encountering dangerous current, provided his heart is sound.

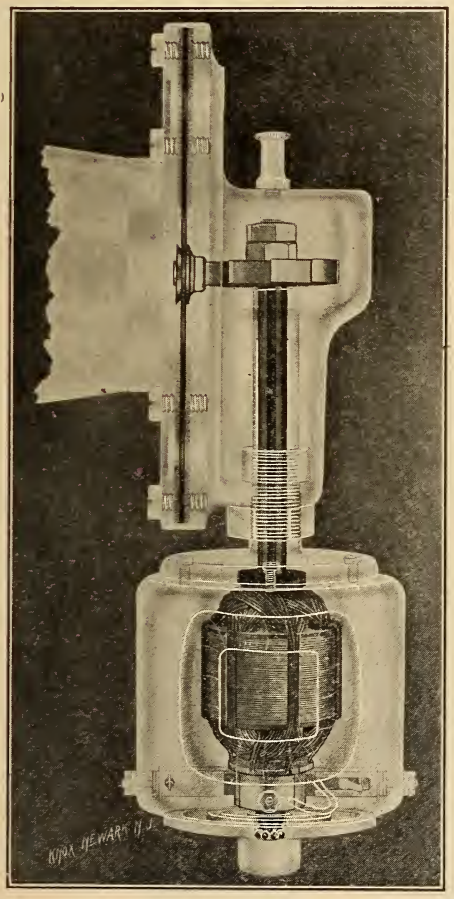
The lectures are a regularly recognized part of the railway work, paid lec-

TEACHING THE USE OF A HOSE IN THE NEIGHBORHOOD OF LIVE WIRES.

turers being employed to educate the men. Those men who learn how to be electrical "first aiders" pass the knowledge on to their associates, and so the work is spreading fast and satisfactorily.

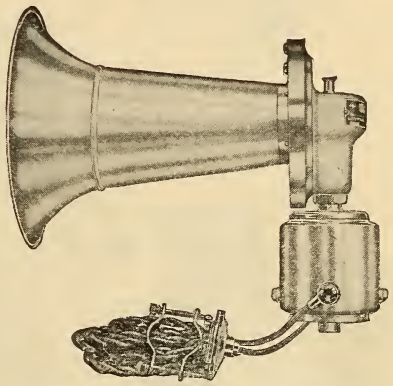
KLAXON—THE X-RAY OF SOUND.

"A creation in discord" is an appropriate phrase to apply to that strange, penetrating and most startling tone combination produced by the Klaxon, the latest automobile warning signal. In appearance the Klaxon is not unlike the ordinary automobile horn, but it is much different inside, being operated by an electric motor instead of air.



INTERIOR MECHANISM OF THE KLAXON.

One of the illustrations shows the interior mechanism. In the base is a small motor on a vertical shaft which revolves at a tremendous speed. On the upper end of the shaft is a toothed wheel, the teeth striking a knob attached to a vertical diaphragm situated in the horn part. The vibration of the diphragm produces the sound—the most unusual and startling roar that ever greeted human ears. It is only necessary to push a button and turn on the current from the battery which operates the motor. The small illustration shows the exterior of one type of the Klaxon with wires to connect it to the battery.



KLAXON HORN COMPLETE.

The note of the Klaxon drowns every other sound in its vicinity. It cuts through fog readily, and carries to great distances in fair weather. For this reason it is an ideal motor-boat signal. It provides for a long-drawn or sharp-short note and starts or stops instantly. You can install it on either side, in any position you wish, and operate it from any section of your boat.

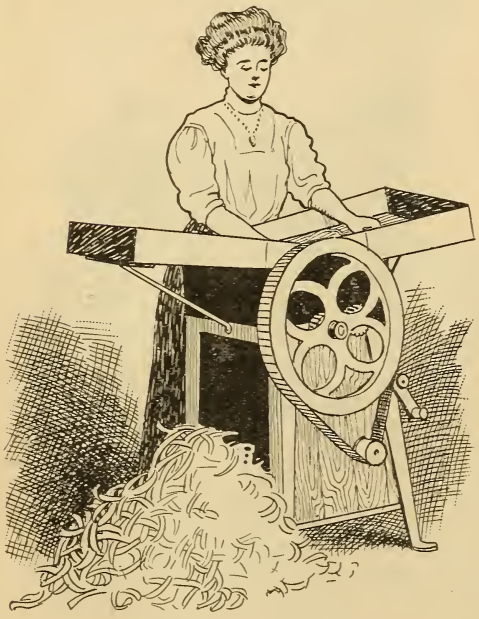
NEW ELECTRIC FURNACE PRODUCT.

A new material has recently been produced in the electric furnace to take the place of platinum for heating elements in electric cooking and heating devices. The new product is called silundum, and is produced by subjecting carbon to the vapor of silicon. The result is a silicified carbon which is similar to silicon carbide and has many of the same properties. It resists temperatures of 1,600°C. and does not oxidize, nor is it affected by acids. As a conductor of electricity its resistance is said to be several times greater than that of carbon.

DESTROYING STREET CAR TICKETS.

Traction companies are much interested in a new ticket destroying device which runs by electric power and literally "chews up" used tickets by the thousands, converting them into a salable product in the shape of waste paper, to be sold to paper mills or for packing purposes.

This machine is so simple that it can



TICKET DESTROYER.

be operated by an office boy or girl. While in operation it occupies a space of two feet by four feet. The feeding boards or tables are hinged and may be dropped down out of the way when not in use. There are two of these tables enabling two operators to feed at the same time, thereby increasing the capacity.

Enclosed in the bottom of the frame is a 5/8 horsepower motor, the operation of which will not be attended by any disagreeable noise in the office. Sixty circular knives of high grade steel 11/32 inch thick are placed on two parallel shafts geared together by cut gears. Each knife is interchangeable. In case of injury to any one of these knives by a piece of metal passing between the rolls, it can be replaced at very small cost.

STANDARD ELECTRIC TIME SYSTEM.

Punctuality is essential to discipline, system and economy in all departments of life. To aid people to be punctual electricity is used in scores of ways, but even the people in whom these various systems are designed to stimulate promptness do not understand their mysterious working.

A modern electric time system consists essentially of a perfectly made, electric, self-winding master clock, which performs the dual function not only of keeping very precise time itself, but of controlling electric impulses to various other time keeping devises of which the system is composed.

The illustration shown herewith represents, diagrammatically, a master clock from which radiate electric circuits controlling time stamps; secondary clocks, which keep the exact time of the master clock, a tower clock motor for operating the clocks in a tower or steeple, and a program clock, which is sometimes used in schools. Electrically operated whistles may be added to the system and many other applications will suggest themselves.

One of the most interesting features of the system is the program clock, which may be used for a great variety of purposes, such as automatic signal work and the automatic starting and stopping of machines. This program clock drives paper ribbons which are perforated for the hours and minutes that signals should be given and thus permit electric circuits to be made through the perforations to the signal apparatus, as the ribbons slowly unwind. One program clock may control from one to eight independent and distinct circuits of signals with any number of bells on each circuit. Furthermore, the program clock is capable of automatically changing the program from day to day by cutting out a program on Sundays or giving any combination of programs that may be desired.

These program clocks have found many useful applications in schools for ringing signals for the dismissal of classes, changing of study periods, etc. There is, however, a wide, economic field for them in industrial work.

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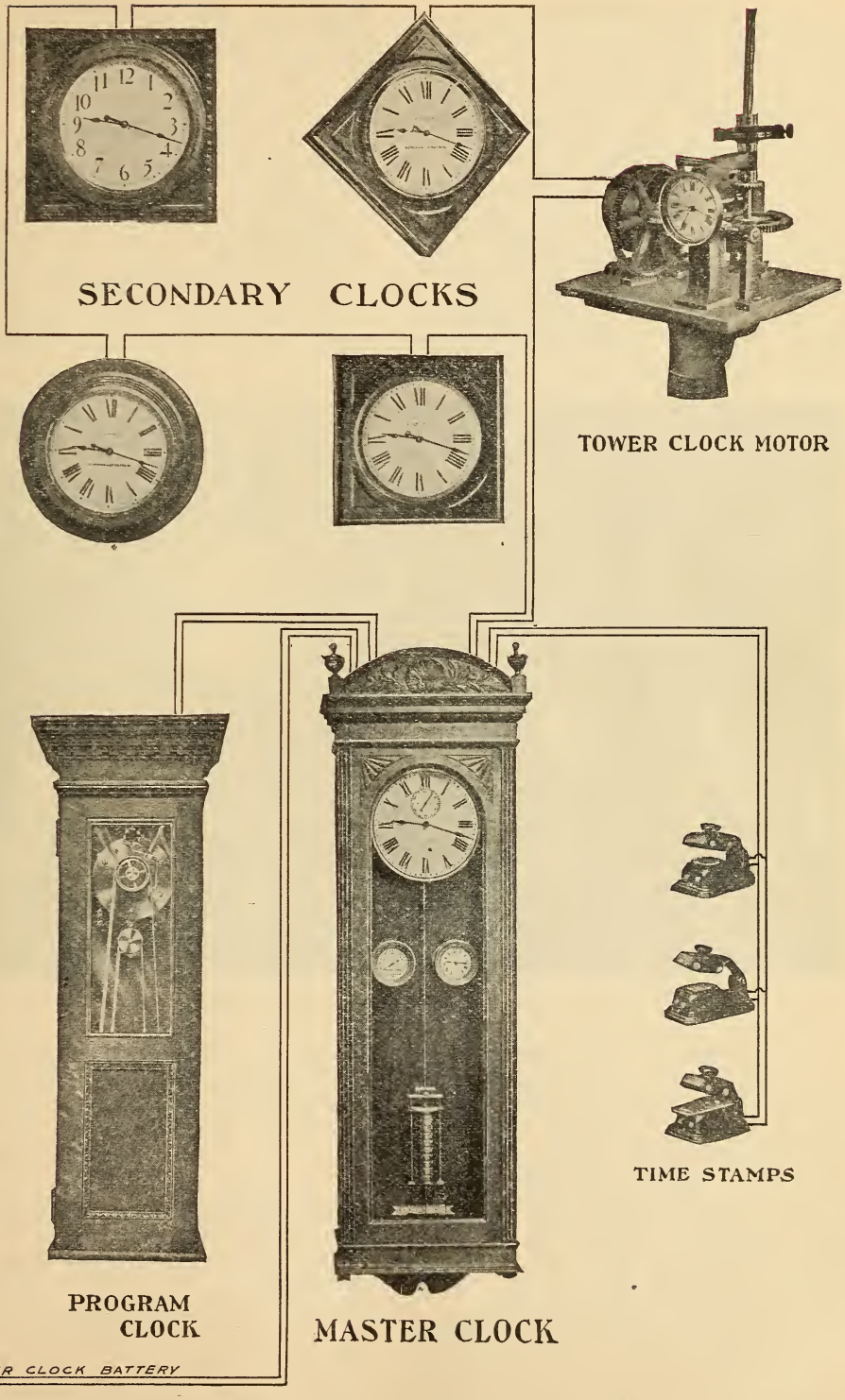


SOME APPLICATIONS OF THE STANDARD ELECTRIC TIME SYSTEM.

EYE COMFORT.

The new method of indirect illumination, called the "I-comfort" (eye comfort) system, which was described in the December issue of Popular Electricity, is now made in what is known as the "adaptable" form; that is, the peculiar inverted reflectors are so arranged that they may be attached to the ordinary lighting fixtures without changing the latter, thus making the new system "adaptable" to the old. The system is meeting with favor in many instances where heretofore it has been difficult properly to illuminate the working plane, but that it lessens the tendency to irritability, and one working under such conditions must be physically and mentally better at the day's end.

A NEW ILLUMINANT.

Plates of aluminum alloy used as electrodes form a new kind of electric lamp that is said to promise efficient and economical lighting. Trial was made with an alloy much used for motor castings and containing 90 per cent of aluminum, the remaining 10 per cent being chiefly copper and tin, with some manganese, iron and zinc and traces of silicon. Im-

INDIRECT ILLUMINATION IN OPTICAL GOODS STORE.

as in counting rooms and places where large clerical forces are employed. It is said that by this system the glare on the books and papers is entirely eliminated.

The accompanying picture shows the "I-comfort" system of lighting applied to a large optical goods store. Adaptables are here used on what were old-style electroliers, the new reflectors throwing the light up on the ceiling from whence it is reflected evenly.

The chief claims made by adherents of the indirect system of illumination are that it not only removes the cause of eye distress and frequent headaches, thereby conserving the bodily energy,

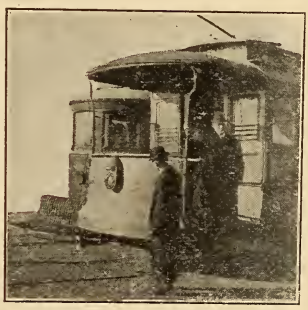
mersed in a solution of common borax such electrodes stand a current gradually brought up to 250 volts. The current causes the electrodes to glow like white hot iron in water without the sparking of pure aluminum, and with a lowered voltage an opal colored light was produced giving the effect of a building lighted with many concealed lamps. Beyond 200 volts small, shifting sparks appeared over a white surface. The glow resembles the light sometimes seen about wires carrying current of very high tension, but in this case there is a static discharge of electricity through the thin film of aluminum oxide coating the plates.

SIGNAL TO PREVENT CAR ACCIDENTS.

A prolific source of street car accidents is for a person to alight from the rear platform, pass around the rear end of the car and step onto the next track right in front of a car coming from the opposite direction and necessarily hidden from view until too late. Its bell may be clanging, but so also may be eight or ten others in the vicinity of a busy corner, and in the rush and turmoil it is so easy to be thinking of other things besides a mere street car.

A device which will prove efficient in preventing this particularly prevalent form of accident has been thought out by Mr. A. O. Nichols of Omaha, Neb. It consists of a signal bell mounted on the rear of the car and operated with a push button by the motorman up in front. When the latter sees a car approaching on the parallel track while his own car is standing still, he rings the signal bell as long as there is any danger. This calls the attention of people passing the rear end of the stationary car to the approach of a car on the other track. The bell casing also bears, in plain letters, the following: "Look Out for Car on Other Track," which is illuminated at night by an electric lamp.

EXTERIOR VIEW.



SIGNAL IN OPERATION.

INTERIOR VIEW.

ELECTRIC CURRENT CONSUMPTION IN NEW YORK.

The New York Edison Company has about 65,000 customers on its lines extending over Manhattan Island and the Borough of the Bronx. Current is fed through 81,000 meters to an equivalent of 6,000,000 lamps. The electric motors taking current from the company figure up about 186,000 horsepower.

ALL DAY SERVICE IN SMALL CITIES.

Time was when electricity was used almost entirely for lighting purposes. During the hours between dusk and daybreak the electric lighting plants ran the generators at their greatest capacity to take care of the thousands of lights burning in the streets, the shops and factories, the offices and homes. But as soon as old Sol peeked above the eastern hills the electrical engineer in the power house opened a switch and the arc lamps in the streets instantly went out, though the red hot tips of the carbon electrodes glowed for a few seconds in the morning light. In a few minutes more another switch was turned and the lights for the houses and buildings were turned off and the great generators soon stopped with no work to do during the daylight hours. The engines stopped running, the machinery stood motionless, the fires were banked, the steam pressure went down, while the engineer and his assistants killed time in cleaning up the different machines and polishing the brass fixtures, or went home to sleep.

But electricity has found so many new fields of employment in the past few years, and has come into such general usefulness in the shop, office and household by day that nearly every public electric power plant in towns of any size at all is now running day and night. The time has arrived when the power plants can earn nearly as much during the day as they do during the night. The electrical energy which was exclusively used for lighting purposes in the past is now recognized as the ideal source of power and an important factor in the heating world.

INVENTIONS OF EDISON—A CLASSIFICATION.

BY JOSEPH J. O'BRIEN.

Edison and invention are two words that have become almost synonymous in the minds of millions. As America has led the world in the volume of invention, so Edison has led in the volume of inventions produced by individuals.

Out of millions of experiments with nature things and with man things this nation has been developed into its present state of greatness. All the wonderful industrial arts of our time are the results of human experience organized by human experiments and developed into the organized knowledge of human science. The experiment is the instrument of invention and the product of experiment is art. Without art man would have remained uncivilized. Civilization, then, is the social effect of art, and since art is the product of invention, civilization is the elaborated effect of human invention.

Future fame will rest largely on the art test and not on the military test, and by this test Edison is greater than Cæsar. A great deal of exaggeration and a great deal of misrepresentation concerning the inventions of Edison have been indulged in. The scope of his work has been carried beyond truthful bounds by some, while it has been seriously underestimated by many writers who occupy positions of authority. In the Encyclopedia Americana it is stated: "More than three hundred patents have been issued on his inventions." This statement was 50 per cent wrong at the time it was published.

Other men have invented more complicated machines than Edison has; other men have solved tremendously difficult inventive problems. But in the volume of output; in the persistency of endeavor; in the brilliancy of experimental resolution, Edison stands forth as the inventor-leader of our time and our period—the wizard of experiment. It was Edison who subdivided the elusive electrical current, in the face of negatively figuring mathematicians, and brought the incandescent lamp out of the field of laboratory speculation and into that of commercial use and success. An achievement which is of infinitely greater importance to the world than the erection of time wearing pyramids of little utilitarian value.

The production of a successful incandescent lamp demanded efficient current generating machines, efficient distributing systems, efficient control systems, and practical manufacturing and business methods. The problem was not merely one of carbonizing bamboo and durable lamp construction, but of economical, gas-competing illumination. Accordingly the entire field of seen possibilities was overhauled by the inventors, with Edison, the master experimenter in the lead. The influence of the successful incandescent lamp upon the entire field of electrical endeavor has never been fully established, but it is now recognized that the science of electrical engineering owes its greatest stimulus to the development of the successful incandescent lamp, which is made up of a bulb having a vacuum and a high resistance conductor therein. The incandescent lamp not only brought about the development of the science of electrical engineering and gave rise to whole industries embracing billions of invested capital, but rendered possible the modern stage, the wonders of which we are only beginning to see.

It was Edison who invented the continuous photographic film which has now been elaborated into an ever expanding art of photographic illustration. This art has brought a world of knowledge to every class and compelled the reform of opinion-ribbed art notions. This art has brought distant cities and peoples to our feet and made world-study a pleasure to the most indifferent. The moving picture theaters are now an established amusement feature of every city, and it is estimated that over forty million tickets are sold each week. Who can estimate the influence of this work upon the minds, hearts and relations of men? We cannot even appreciate it as yet.

John Philip Sousa says that the phonograph gave us "canned music."

Certainly. So did photography give us "canned" images and movements. So did type give us "canned" knowledge and "canned" history. In fact this work of canning things, of canning records, images, memories, tones, songs, voices, movements, events, forms a very vital part of the work of civilization. Since it is by art man advances it is by man's efforts in preserving and experimenting with art that art advances, and the advance of both involves the transmission of intelligence.

In order that the general scope of Edison's work might be better understood I have classified the patented inventions of Edison, and for the first time here give the general results of this classification in the following table. This classification does not attempt to give all of the many details of Edison's inventions, but does give the reader an accurate idea of the fields into which Edison has worked with results.

NAME OF ART.	MINOR ART.	PATENTS
Electrical Power Machinery.	Generators, Motors, Regulators, Governors, Machine parts.	123
Electrical batteries.	Storage batteries, Generating Batteries, Thermo-electric batteries, Processes of manufacture, Manufacturing aids, Battery parts, Gas manipulation.	64
Measurement of Electricity.	Meters, Controlling temperature of.	17
Distribution of Electricity.	Systems of distribution, Conductors, Fuse blocks, Junction box, Lightning arrester. Converters.	60
Electrical Communication.	Telegraphy, art of, Telegraph circuits, Telegraph instruments, Telegraph instrument parts, Telephony, Telephone instruments, Telephone circuits, Telephone parts, Signaling, Signaling instruments, Signaling boxes.	178
Electrical Illumination.	System of electric light, Incandescent lamps, Arc lamps, Fluorescent lamp, Filaments, Manufacture of filaments, Manufacture of lamps. Vacuum pump, Carbonizer, Thermal regulator, Safety conductor, Lamp parts, Electric chandelier, Conductors, Cut-outs.	190
Electric Traction.	Electric railway, Electric locomotives, Propelling mechanisms, Railway systems, Turn tables, Trolleys, Insulation, Handling cable cars.	22
Phonographs.	Phonographs, Blanks, Phonograph parts, Phonograph dolls, Manufacturing blanks, Manufacturing tools.	98
Electroplating and Electrometallurgy.	Metal plating. Tools for plating, Electrolytic composition, Electric welding, Metabolizing iron.	11
Ore Manipulation.	Magnetic ore separators, Method of ore separation, Magnetic ore controlling, Grinding Machines, Ore conveyors, Screening, Crushing machines, Extracting ores, Mixers, Briquet making, Composition brick, Compressing dies, Making cement, Cement kilns, Cement, Drier	65
Photography.	Kinetoscope, Kinetographic camera, Kinetoscopic film.	4
Office Appliances.	Electrographic vote recorder, Autographic printing, Typewriting machines, Addressing machines, Autographic stencils, Stencil pens.	9
Journal Bearings and Gearing.	Expansion pulleys, Lubricating journal bearings, Shafting, Vehicle wheel, Dustproof bearings, Dustproof swivel gearing, Magnetic belting.	9
Glass.	Process of making glass, Apparatus for making glass.	3
Compressed Air.	Reheating compressed air.	2
Wire drawing.	Method of drawing wire.	1
Fruit preserving.	Vacuum fruit preserving.	1
Weighing.	Automatic weighing apparatus.	1

SUMMARIES.

Total groups of main arts	18
Total subdivisions of main arts	103
Total number of patents	858

The above classification is the first of its kind that has ever been published and deserves particular consideration for this, if for no other reason. It places in a concrete shape the inventions of Edison and enables the layman to readily ascertain what fields the "Wizard" has invaded with patent results. The electrical character of Edison's work is seen at a glance. Telegraphic

work led to the vote recorder, to the stencil pen, which in turn opened up the way for various office appliances, and to the larger field of telephonic invention. Telephonic work led to phonographic work, while general work with the electromagnets led directly to the magnetic ore separator. The magnetic ore separator opened up the field of mining and cement, which now promise some new wonders. The electric lamp led to generators, distributing systems, meters, regulators and manufacturing processes. As a by-product of vacuum work we have Edison's contribution to the art of fruit preserving by means of a vacuum. The generation of electrical energy and the commercial exploitation of that energy compelled work on storage batteries, which work continues without interruption.

The entire work of Edison presents a consistent evolution of things electrical in nature or in relation, and if one attempts to trace this work beyond the years of our time he will find it leading to the workshops and laboratories of Europe; to the "dancing frog" of Galvani; the "electric pile" of Volta; the magnet of Sturgeon; the discoveries of electro-magnetism; dynamic generation, and the differences between insulators and conductors. Without the magnet and the battery Edison could not have built up his magnificent work and it is to Europe that we owe these vital contributions.

CONTROL OF MOVING PICTURE ARCS.

Arc lamps for moving picture machines operate on approximately 35 volts and 40 amperes. Now 35 volts is away below that of the usual lighting circuit, which is about 110 volts. Therefore, the arcs cannot be operated directly across the light wires without the use of a device called a rheostat. The latter contains a lot of iron wire of high resistance connected in series with the arc lamp to keep too much current from flowing through the latter. But the rheostat itself consumes current which costs money, and besides, gives out a lot of heat which is uncomfortable in the close quarters usually occupied by the operator.

A device designed to eliminate the rheostat is called the Compensarc, shown in Fig. 1. This is on the order of a transformer to reduce the voltage of the lighting current to a value suitable for

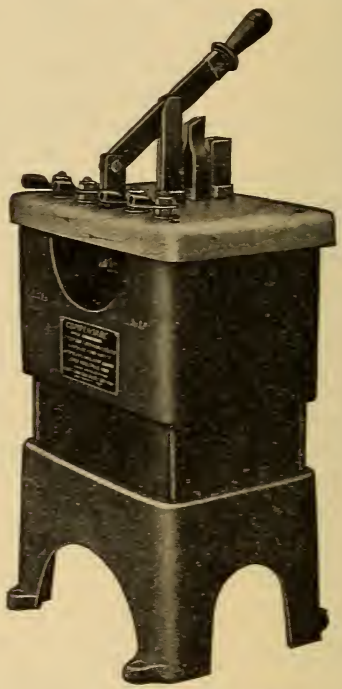


FIG. 1. THE COMPENSARC.

the arc lamp. Unlike the ordinary transformer, however, it is provided with various adjustment features to maintain the arc of a constant strength and uniform

FIG. 2. ECONOMY-ARC.

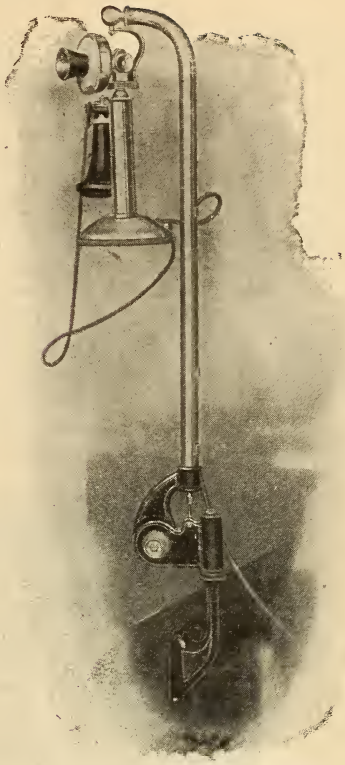
quality so essential to the production of clear and steady pictures.

Another apparatus known as the Economy-arc, Fig. 2, is also a saver of

light bills. The regulation made possible by this device overcomes varying conditions such as result from different densities of films and different distances between lamp and screen. For the convenience of the operator the attachment wires are brought out through porcelain bushings in the casing, and each pair is marked, one "line" and the other "lamp," so that wrong connections cannot be made.

RADIO ADJUSTABLE TELEPHONE HOLDER.

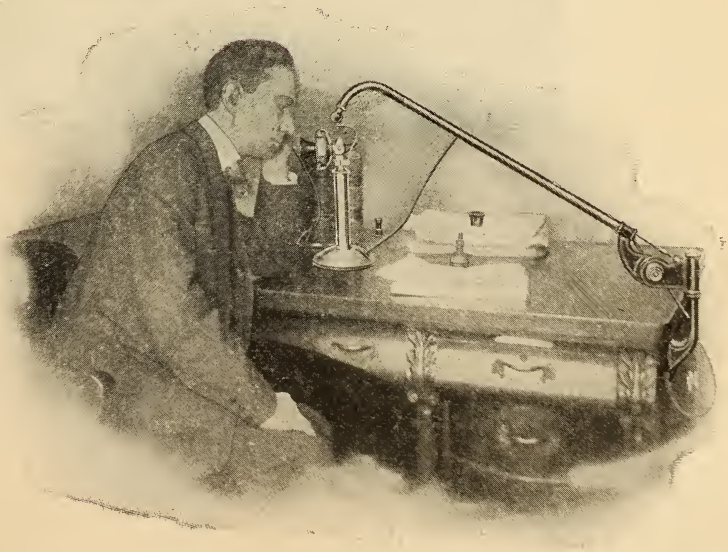
The Radio adjustable telephone holder is the latest invention of Kempster B. Miller and Samuel McMeen of the firm of McMeen & Miller, telephone engineers. It is adapted to any make of desk telephone and can be mounted on a desk or table or on the wall or floor. By a simple and easily adjusted device which clamps around the upper part of the telephone the latter is flexibly suspended from the arm, always in a vertical position. The arm in turn can be moved around in any position, up or down or sidewise and will stay perfectly balanced in any position.



RADIO ADJUSTABLE TELEPHONE HOLDER.

Some of the advantages of this unique holder are the following: Permits one telephone to serve four people without getting up from their desks; when not in use the telephone is off the desk and out of the way; can be used standing up or sitting down; holds the instrument always in a vertical position unless the user desires to tilt it while talking.

The convenience of a movable holder for the telephone can only be appreciated after it has been in actual use. The ordinary desk telephone, with its usually tangled cord, will occupy about a square foot of desk space and is always in the way. An unlucky move will often push it off onto the floor, and the result is a broken mouthpiece if nothing more serious.



RADIO TELEPHONE HOLDER IN USE

THE DICTOGRAPH.

The Last Word in the Conservation of Business Energy.

BY JOSEPH B. BAKER.

How to conserve the time and attention of the overdriven executives of the modern business world is a serious problem. In the great organizations of today the utmost efficiency of operation must be attained. This iron condition of success has a particular bearing in the matter of the countless written and oral communications of all kinds that are carried on. In the life-and-death struggle of competition, every day is a day of battle in which he holds the supreme command. Should not the contact between the giving of his orders and their intelligent obedience be as direct and close as it can possibly be made?

PRESIDENT OF A LARGE COMPANY DICTATING THROUGH THE DICTOGRAPH.

Let us examine briefly the different ways that the busy executive ordinarily has at his disposal for impressing the decision of his master mind upon others, to be by them transmuted into action.

First, for things requiring immediate service, he may speak directly to his secretary, managers, or other assistants, in the same room, or he may press a button to summon them from another room. Second, for things that need not be done on the instant, he may dictate instructions to a phonograph for writing or execution later. Third, for things not needing to be written for him, he may pick up a telephone and talk with people in his own building, in other parts of the city, or in distant cities.

All these three ways of imparting the mind of the executive involve wasting his time and attention; they are little leaks of his valuable dynamic energy scattered through his day of five to seven hours, and making a large aggregate loss.

The first way is the most wasteful. Suppose he needs his secretary, acting as his personal stenographer. If he prefers to have the secretary constantly nearby, in his private office, there is direct communication to be sure, but this time-saving may be more than offset by the intermittent noise of her typewriter. But if she is in an adjoining room there is the time she takes in coming into the office

in answer to the call—including the few seconds consumed in gathering up her note-book and pencil, and perhaps also taking a letter out of her machine, arranging her papers, or making a memorandum. Whatever the time is, an irreducible minimum of seconds is lost in this way which is an unconscious irritation to the executive, who "wants what he wants when he wants it."

The second way—the use of the phonograph—is helpful to some extent, and has a field of usefulness. But the utter lack of the human element is often objectionable; and the only way the machine saves a man's time is by enabling him to give his dictation at his convenience without requiring the presence of the typist.

The intercommunicating telephone system is a time-saver, but has no application to dictation. From the viewpoint of the busy executive it has the serious objection of holding him up pretty completely from other activities for the time being.

How can all this waste of time and energy in the machinery of business communication be abolished? For the busiest man, carrying the heaviest responsibilities, the clock goes 'round just as fast as for the idlest and least burdened. Is not some better, freer route to the minds and hands of his assistants possible?

The solution of the problem is the Dictograph, an instrument which eliminates all the "lost motion" between the executive and his subordinates by establishing immediate oral communication with them without the ordinary transmitter to be talked into, or a receiver to be held to the ear. Impressing his mind is reduced to the simplest conceivable process—mere unencumbered vocal utterance.

The Dictograph, as it appears on the executive's desk, consists of a small box containing an extraordinarily sensitive transmitter and a loud-speaking receiver. An ear-piece receiver is also provided. On the front of the box are a number of simple electric switches and signals. That is all there is to the "master station."

Even less pretentious are the "sub-stations" which are installed on the desks of the subordinates and each of which is connected by wire to the master station, where it terminates in a switch and signal. The sub-station consists only of a transmitter and an ear-piece receiver. The latter may be held against the ear by a head-band, like that used by telephone operators, so as to leave both hands free to manage note book and pencil.

In using the Dictograph no "Central" is necessary. In fact the manipulation is so simple as to leave almost nothing to describe! The executive does everything by direct vocal utterance, without having to approach a telephone instrument, in fact freed entirely from the paraphernalia of the telephone. A simple movement brings the subordinate's ear and voice to receive and acknowledge instructions spoken in an ordinary tone. To dictate a letter, for example, one touches one of the little levers on the Dictograph box. This signals the stenographer, and her reply emanates from the box just as though she were actually sitting beside one's desk, though in reality she is sitting at her own desk in another room. One then proceeds with the dictation, speaking right out into the air in the customary way, every word being heard and taken down by the stenographer at the other end of the wire. If the dictator wishes, he may get up from his chair and walk about the room while dictating, speaking part of the time with his back turned; yet every syllable is caught by the stenographer through the sensitive electric ear on her employer's desk. Should secrecy of reply be desired, he may silence the loud-speaking receiver and use the ear-piece instead.

A demonstration of the Dictograph gives to a busy man a vivid realization of how many of his ideas have been evaporating, how much of the freshness and vigor of his letters have been lost. Then there is the secrecy attained. The physical presence of a stenographer or other persons in the private office has a dampening effect under some circumstances. Many a business deal has gone awry because the principals felt unable to talk freely.

Where this system is installed conferences may be held over the wire without any of the conferees leaving their desks. The system lends itself no less admirably to more formal conferences. A master station on the board-room table at a Di-

rectors' meeting enables any of the directors to speak with any one in the establishment—to obtain needed information, receive messages, etc. — without leaving his associates, or losing touch with the proceedings.

The apparatus, which is made by the National Dictograph Company of New York, has already been installed in several prominent banks, trust companies and large commercial institutions in New York, Chicago and elsewhere.

TRACKLESS TROLLEYS OF VIENNA.

By trackless trolleys are meant electric buses or automobiles which follow the pavements or country roads as an ordinary road vehicle but which derive their current from an overhead trolley wire, as in the case of a street car which runs upon rails. They have not been operated with success in this country, but in Europe there are a number of systems in use which are apparently economical, due, no doubt, to the excellent road beds that there prevail. One interesting line of this character is at Weidling, near Vienna, Austria, and is 2.3 miles long, with gradients as great as 7 per cent.

TRACKLESS TROLLEY OMNIBUSES.

There are five trackless trolley cars or omnibuses in service, each carrying 21 passengers. About 100 miles are run daily from 5 o'clock in the morning until midnight. With three cars running, 2,700 passengers are carried without difficulty on Sundays. Only 10 seconds are required for interchanging the trolley cables at the meeting of the cars, this being done at any point on the line.

It is maintained that the two 20-horsepower motors on these omnibuses may be overloaded to double their usual output, in emergencies, without getting dangerously hot. The cars weigh only 2.5 tons each, and this small weight, compared with the load carried, has an important bearing on road surface wear, rubber tire wear, and consumption of current.

This trackless trolley system is the invention of Ludwig Stoll of Vienna, and among the strong claims made for the

system are its simple, rapid, silent and smooth running, as well as its freedom from breakdowns and interruptions of service.

Current is collected by a little wheeled arrangement which runs along on the trolley wires and from which flexible conductors depend, conducting the current to the car. There are two trolley wires, one positive and the other negative.

It is stated that the trolley runs with little or no sparking, the wheels running on ball bearings, and the pull of the cable acting upon a very short lever-arm. The center of gravity of the trolley is very low, so that there is no deviation of the trolley in spite of strong transverse pull, the conducting cable being long enough to follow the car. There is an upper sliding knot tied up on the pendulum weight, as shown in the illustration, and stretched by means of a spring from the latter. There is also provided a cable roller with 30 or 40 feet of cable which is let out or rolled up by means of a spiral spring.

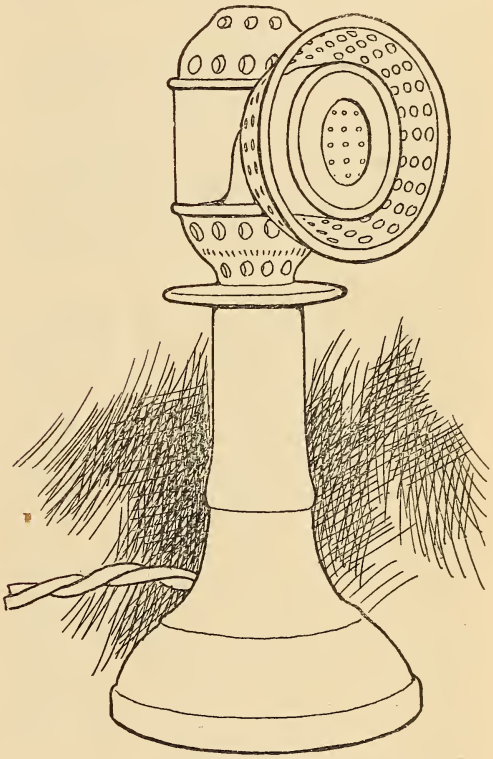
By the use of these two appliances the car is allowed to run on the whole width of the roadway, to turn out in overtaking or meeting automobiles or other vehicles and accommodate itself to every form of traffic. When two trackless trolley cars meet the motormen simply interchange the trolley cables by detachable contact boxes, this being a decided advantage over a single track electric railway on which much time is lost in waiting at passing points.

EARTH CURRENTS.

Great local differences in the electrification of the earth are known to exist, and a German engineer suggests that with better knowledge it may be possible to make mining for electricity as profitable as digging for coal or metals. In experiments in two comparatively shallow borings, he has obtained weak currents between a small rod of brass or iron immersed in the water of the pit and a similar rod buried near the surface. He urges that contractors, mining companies and others take up the problem, and perform such experiments as testing the current between a 60-foot copper cylinder at the bottom of a boring of thirty thousand feet or more and a similar cylinder buried in moist ground at the surface, also investigating the charges to be obtained from long iron pipes buried in the ground.

CIGAR LIGHTER.

No doubt the desk telephone, which is so indispensable in all offices, suggested the unique design of the cigar lighter shown herewith. This lighter is made with a substantial base and the heating



CIGAR LIGHTER.

element is contained in a projection on the side which looks very much like a telephone mouthpiece. The wires from the lamp socket lead into the base and being flexible permit the lighter to be moved around readily over the counter or showcase.

To demonstrate that the electric chair does not kill, but makes victims comatose, it is said that a New York man, Charles Quill, allowed 1,800 volts to pass through his body. Quill was not injured in the test.

POPULAR ELECTRICITY WIRELESS CLUB.

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine is devoted to the interests of the Club and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments.

SPARK COIL CONSTRUCTION AND OPERATION.

BY VICTOR H. LAUGHTER.

PART I.

One of the most popular electrical instruments for experimental purposes is the induction coil or spark coil, as it is commonly called. The experiments that can be performed with it are numerous and since the practical introduction of wireless telegraphy, it has come into wide use as the means for setting up the wave energy.

More attempts are possibly made by amateurs to construct the induction coil than any other piece of electrical apparatus and with poorer results. The reason is obvious. The induction coil requires careful work, and parts which are designed to work in conjunction with one another to obtain results. This rule is not usually followed out by the casual experimenter. The insulation is overlooked, and the various parts are selected by guess work. Results are of course poor, and the builder of the coil finally gives up the work in disgust. However, this need not deter anyone with ordinary ability from taking up the work, for if patience and care are used satisfactory results may be obtained.

As the same plan of construction is followed out with all spark coils, only one size will be described here, but dimensions of the other sizes will be given. The amateur may then construct any other size by following out the same general plan.

The spark coil complete constitutes the following parts: Iron wire core; primary winding; insulating tube; secondary winding; vibrator, and condenser. The complete parts as connected up for use are shown in Fig. 1, in which (A) represents an iron wire core, (B) the primary winding, (C) the insulating tube and (D) the secondary winding. The complete vibrator is made up of parts (G), (M) and (F). (H) is the condenser and (I)the battery. Before going into the construction it would be advisable to study out the action which takes place in a spark coil in operation, as this will give a clearer idea of the parts

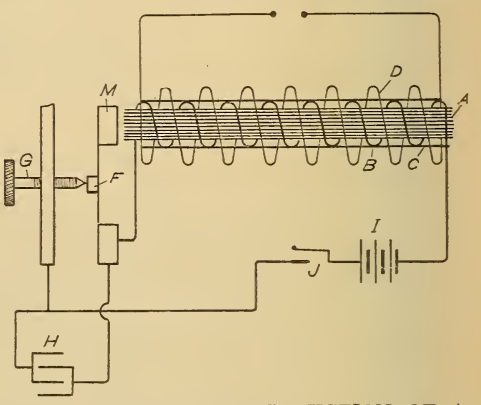


FIG. 1. GENERAL CONSTRUCTION OF A SPARK COIL.

involved. We have the core (A) which is a circular bundle of soft iron wires. Over the core is wound the layers of heavy wire known as the primary winding, and over the primary a large number of turns of small wire known as the secondary. The two windings are insulated from one another by the tube (C). The primary winding leads down to the battery at (I) and to key (J), and from the opposite side of the key (J) to the metal post which supports the screw (G). The screw (G) is platinum tipped and rests against the second platinum contact (F), which is mounted on a brass spring strip bearing the soft metal disk (M) fastened on the end. This strip as shown is connected to the remaining

terminal of the primary winding. The secondary terminals lead up to binding posts mounted on the top of the coil case.

When the key (J) is closed the current circulates from the battery (I) around the windings over the iron core and completes the circuit through the contacts- (F) and (G). The electrical current flowing through the primary winding sets up magnetic effects in the core, which extend out in invisible lines through the secondary winding. As the disk (M) is of soft iron it is susceptible to magnetic effects and will be attracted towards the coil (A). The disk in its forward movement pulls the spring which breaks the circuit at the contact (F). The current now ceases to flow, and as the core is magnetic only as long as the current flows, the pull on the disk is released, allowing it to fly back to its original position only to repeat the operation over again. At each "make and break" a pressure of several thousand volts is induced in the secondary winding, this action being due to the high ratio of the secondary to primary turns. The current induced in the secondary flows to the terminals and jumps the spark gap. The length of the spark gap the current will jump is largely determined by the adjustment of the "make and break" device, commonly called the vibrator. The condenser (H) connected across the vibrator contacts serves a useful purpose. The spark at the contacts would be very large and hot and would soon melt the platinum if it were not for the fact that the condenser takes up this spark in the form of a charge and in turn discharges back into the primary winding.

Now that the operation of the coil and parts used have been described, the actual construction will be taken up.

In view of the fact that the amateur prefers a coil that can be used for nearly all ordinary laboratory work, one of the four-inch size will be described. A coil of this size can be used for wireless telegraphy up to a distance of 10 to 20 miles, and for X-ray work, lighting Geisler tubes and numerous other purposes.

CORE.

The core is usually one of the most neglected parts of the coil, whereas, it is one of the most important features. The desired feature of the core is that it should be made of very soft and small iron wire, cut to the exact length, with as many pieces forced into the bundle as possible. In all cases the wires should be well annealed. The reason for using a large number of small wires for the core, in place of a solid iron body, is that a core of the first named type is capable of taking on and losing the magnetic effects much quicker than a core of the same metal in a solid body. That is, the solid core would not take on and unload the magnetic effects as fast as the vibrator worked, which would result in a weak and stringy spark. We have this same action in a condenser in a slightly different sense, which will be explained later. A core built up of a large number of small wires is said to be of the laminated type, and we find the principle of lamination extended to other electrical instruments.

A core for the coil in view should be 10 inches long, 1⅛ inches in diameter, built up in a circular bundle of soft iron wires. In view of the important part the core plays and the difficulty experienced in building it up, the writer would recommend that the amateur buy it complete, as the cost will not exceed 50 cents. However, some may prefer to perform the actual construction. First get a sufficient quantity of No. 22, well annealed, soft iron wire to form a bundle 1⅛ inches in diameter, the wires being previously cut to the proper length and made straight. To form the core first roll a tight flexible paper tube to the desired diameter and glue. Fill the tube as full as possible with the core wires and roll with pressure between two boards. This will cause the wires to cling more closely together. Remove the tube and force in more wires, continuing the operation until the tube is full and has taken on a circular shape. Next wrap the tube from end to end with unwaxed shoemaker's thread, making the respective turns fit evenly and neatly together. Over the thread is now wrapped about 15 layers of thin porous tissue paper, and the whole boiled out in a half and half mixture of paraffine and beeswax, for at least 30 minutes, or until all bubbles cease coming to the surface.

The primary winding is made up of

two layers of No. 14 single cotton covered magnet wire wound on the core continuously to within ¾ inch of each end. A lead about four inches long should be left unwound to connect to the vibrator and battery. The respective turns of the primary winding should be made as neatly as possible, for kinks, etc., will to a certain extent impair the working efficiency.

The completed core and primary winding is illustrated in Fig. 2. When completed as shown the boiling out process is gone through again.

THE INSULATING TUBE.

The insulating tube for the small size coils up to 1½-inch sparks can be made

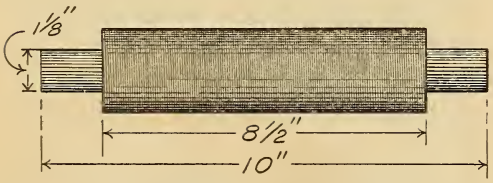


FIG. 2. COMPLETED CORE AND PRIMARY WINDING.

by winding several layers of paper to a tube of the desired size and boiling out with paraffine. But for the larger sizes a tube of hard rubber is recommended. The insulating tube for our proposed coil should have a total length of 9½ inches, 1¾-inch inside diameter, and 2⅛-inch outside diameter. The tube, however, should make a neat fit over the primary winding, and if any additional space remains between the two, fill in with paraffine.

THE CONDENSER.

While it will be some time before we come to the point where the condenser is put in actual use, since the drying out process takes several days, it should be constructed at the present time so that when the rest of the work is finished the condenser will be ready for use.

The condenser will require about 3,000 square inches of tin foil as the total area. The sheets can be cut up in 6 by 8-inch sizes, as this will reduce the number of sheets, over a smaller size. However, any other size can be used. As the sheets will run 48 square inches to the sheet this will necessitate 64 such sheets, giving a total of 3,082 square inches of foil, allowing the extra number of inches for losses involved in cutting and assembling.

The dielectric or insulating medium which separates the foil sheets from one another should be selected with care. A good grade of thin bond paper cut in sheets of 8 by 10 inches makes an excellent insulating medium.

For building up of the condenser a baking pan about 12 inches wide, 14 inches long and two inches deep will be needed, also four pounds of paraffine wax, and a common squeegee print roller. Sixty-four strips of foil 1 by 3 inches are cut, to be used for the connecting strips of the respective foil sheets.

The pan is placed on a stove and the paraffine heated until it is in a boiling state. It is advisable to place the pan containing the paraffine in a second larger pan, with water poured around, as this will prevent the paraffine from becoming overheated and catching fire.

A number of paper bond sheets are now placed in the pan and boiled for about 30 minutes. The sheets are removed and held up by the different corners so that the superfluous wax will run off as evenly as possible. Lay the sheet down on some flat smooth object and place on it, in the center, a sheet of the foil. This will allow a one-inch margin around the edges. One of the foil connecting strips is now placed on, in such a manner that one inch rests on the foil sheet, and one inch clear of the paper. The squeegee print roller is run over the foil with some pressure, which makes the paper and foil adhere more closely together and forces out the superfluous wax. This operation must be carried on while the wax is still soft.

The next sheet of paper is taken from the wax pan and made to fit over the first and the foil sheet as neatly as possible. The second foil sheet is placed on and rolled down as before, but the connecting strip is led out to the side, opposite from the first. That is, if the first strip leads out to the left-hand side, the second should lead out to the right-hand side. This is made clear by reference to Fig. 3. The heavy black line (A) represents the insulating medium, and the line (C) the foil and connecting strip.

Owing to the fact that condenser capacity should be varied until the best re-

sults are had, the condenser should be divided up into banks, and more or less of these banks are cut into the circuit until the point has been reached where the spark is flowing across the terminals with the maximum value.

A very good division can be made by dividing up the condenser into two banks

FIG. 3. GENERAL PLAN OF CONDENSER.

of 16 sheets each, one of eight and two of four. This will give a large regulation and allow the condenser to be used for other purposes than across the vibrator contacts of the spark coil.

Considering that the 16 sheets have been built up according to the method stated, the condenser is ready to be mounted. However, it should be clamped between two boards with considerable pressure, and left over night. This will close up all air spaces, which to a large extent are responsible for punctures across the foil sheets.

As the exposed ends of the foil strips are very delicate and liable to be broken when handling, thin brass strips one inch

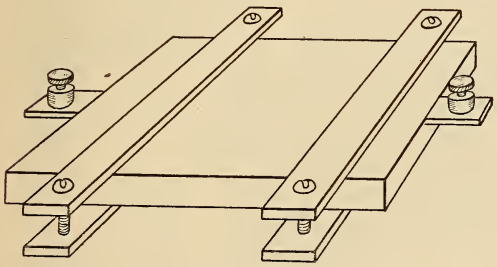


FIG. 4. COMPLETED CONDENSER.

wide and two inches long should be folded over the exposed portion, and holes punched through and binding posts screwed therein.

The condenser is now placed between two thin oak boards, which neatly cover the surface, and additional strips placed over and screwed together at each end, which will clamp the boards tightly in place. The completed condenser is illustrated in Fig. 4. The total number of banks can of course be clamped together in this manner, and this is recommended where it is desired to mount the whole in one case.

After the building up of all the different banks, a case is provided in which the whole number can be placed, and the plug contacts mounted on top so that the different adjustments can be quickly made by the operator. A convenient and simple method for making the plug connections is shown in Fig. 5 (aa) represents two of the banks built up of 16 sheets each, (B) one of eight sheets and (CC) two of four sheets. As will be noted the leads from one side of the condensers are all connected to one wire in common and connection for the opposite side is made

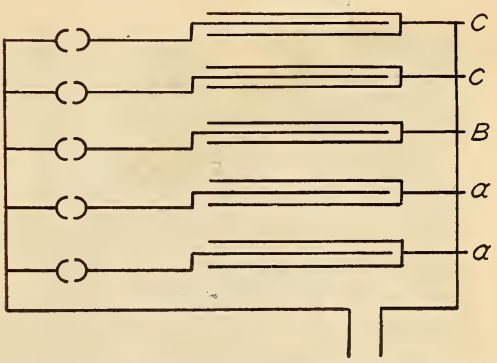


FIG. 5. CONVENIENT METHOD OF MAKING PLUG CONNECTIONS.

by inserting plugs in the various plug contacts. The exact method of mounting is left to the builder's needs and means. By following this general plan the amateur should have no difficulty in constructing a condenser for any size coil, as any changes to be made in the size of the parts, from the dimensions given, would in no way affect the working efficiency.

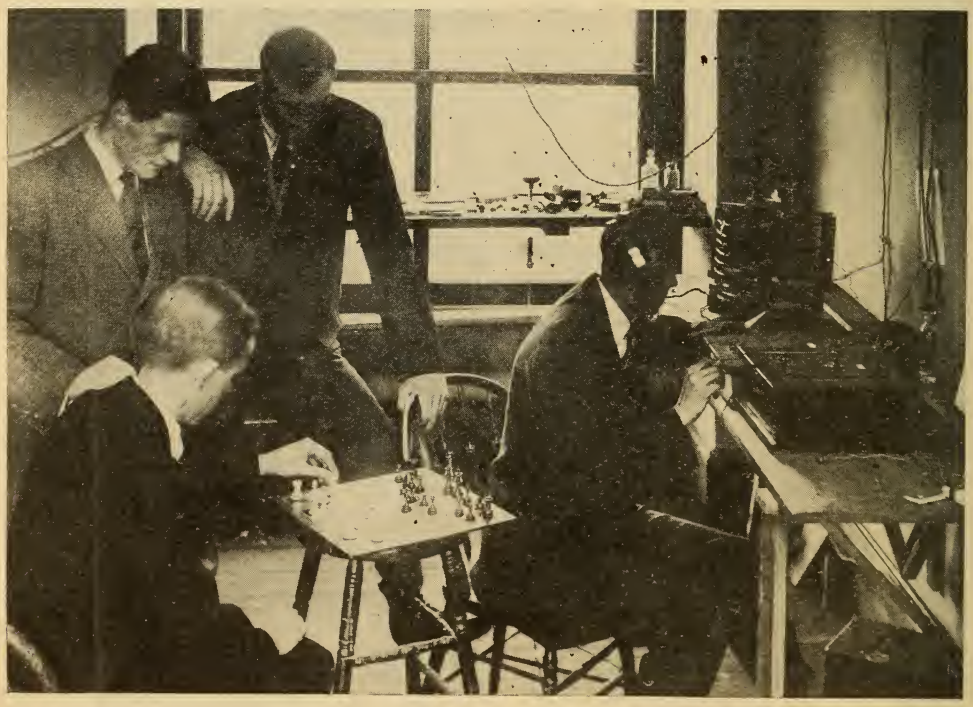
For small size coils the rolled type of condenser is sometimes used. The construction of such condensers is very simple. Two long strips of foil are placed over one another with a strip of paraffine paper between, and rolled up into a solid body with terminals left out for connecting. However, this type is not as efficient as the type previously described. The condenser, as previously stated, in this respect resembles the iron wire core.

To give efficient results the condenser should be capable of taking on and discharging the sparks at the vibrator contacts as fast as the latter operates. Where the rolled type is used it takes a long time for the condenser to absorb the spark, and a certain amount of the energy leaks through and is lost during the cycle. With the alternate layer type the charge and discharge is made rapidly and a better spark is had.

(To Be Continued.)

WIRELESS TO LINK AMERICAN UNIVERSITIES.

Princeton leads the way in a new project the object of which is to link by wireless the principal colleges and universities of the country. Princeton has an outfit, set up in Science Hall, which is the first of a chain of these up-to-date equipments that will make it possible for a conversation to be carried on with other seats of learning when they have equipments. An inter-collegiate chess series might be conducted through the air, students could exchange views on athletic matters and questions of import to the debating societies and other scholastic organizations, all without the expense of a telegram or the delay of communicating through the medium of the mail.



CHESS GAME PLAYED BY WIRELESS.

One afternoon a chess game by wireless was carried on between the students of Princeton University and the experts of the ships at the Brooklyn Navy Yard. Naval men are keen players of the game, for the leisure that is found at sea is encouraging to the development of chess students. The game was carried on entirely by wireless and was followed with lively interest by spectators at both stations.

When the other colleges have installed the wireless outfit, chess by this means will become a regular feature of

the competitive program of the universities. There is no difficulty in the way. During the game referred to a student who was a "wireless" expert sat with the receiver at his ear and called off the moves as fast as they were made. The method was far quicker than the cable game, for the moves were recorded by wireless to a man who sat a few feet from the board and by him were passed on verbally to the player.

"The future program," said a student who has been largely instrumental in rigging up the wireless plant at Princeton, "is to have a receiving station at the athletic field so that the results of athletic games can be made known instantly, and reported during the progress of the game, by the students themselves. This wireless station will be a permanent thing. At all big games we now have the regular telegraph installed so that the spectators can be kept informed of the progress of events at other grounds that are interesting, but there are minor days when the telegraphic machinery is not there to give us this information, and with our own plant we can keep posted on everything that goes on without having to depend on outside sources.

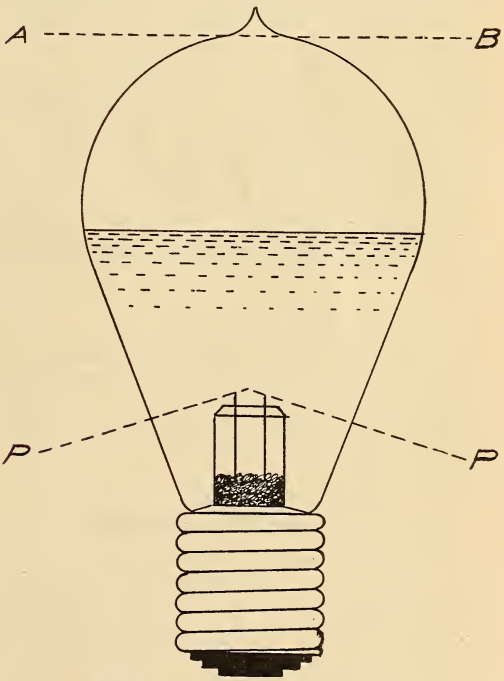
"If there are important events in progress at Franklin Field, for instance, and it is not possible for many of the men to attend them, those interested in the results can gather at the hall in which our wireless is placed and keep in touch with the situation every minute without any expense to themselves or the college. What a boon this will be only college men know.

"We are longing for the time when other universities will have their wireless outfits working. At present we practice on the ships in New York harbor, on our friends of the Navy Yard, and with any operator that we catch idle. There are numbers of ships in harbor whose operators are glad to get in conversation with anyone to while away the tedious hours, and we exchange conversation with these chaps, and occasionally pick up one who plays chess. But there is a growing feeling of resentment among the regular operators against idle wireless men who throw conversational messages on the air. It interferes more or less with the carrying on of legitimate wireless business and the air is becoming so surcharged with these 'Good morning, have you used Bear's soap?' messages that there is talk of legislation to protect the regular companies.

"For this and other reasons we are looking forward to the time when the inter-university conversation by wireless will be an accomplished fact. Then we shall drop the Jack Binnses of the harbor and converse only with our own."

HOW TO MAKE AN ELECTROLYTIC DETECTOR.

One of the things which a "wireless enthusiast" is always looking out for is a good detector, and it will be found by experience that the electrolytic gives the most satisfactory results. Here is the description of one which gave the writer very good results, being very inexpensive yet efficient:



ELECTROLYTIC DETECTOR.

Take a five-candle power lamp globe and break the tip off as shown by the dotted line (A B) in the cut. Smooth off any rough edges with an alcohol lamp and break off the fine filaments and turn the platinum points in till they are about one-sixteenth of an inch apart. Now

screw the globe into a wall bracket and screw the whole on to a suitable base.

Next fill the globe about two-thirds full of a solution made by dissolving one part sulphuric acid to four parts water. Connect up as you would any electrolytic detector. Under ordinary conditions the detector will work very well.

F. ERSKINE HENEY.

3,000-MILE EQUIPMENT FOR WASHINGTON.

The new wireless tower and equipment at Washington, D. C., will have a radius of 3,000 miles. So say the specifications upon which bids are made by the various wireless construction companies. The specifications also state that the messages are not to be interrupted by atmospheric disturbances or by interference with neighboring stations.

At the same time the department asked for bids for two sets of apparatus to be installed on naval vessels to be capable of transmitting and receiving messages at all times, seasons and latitudes, to and from a distance of 1,000 miles, and to receive messages from the Washington station at a distance of 3,000 miles at all times.

The bids submitted indicated a lively competition, seven firms submitting proposals. The most satisfactory of these, according to the officials, was one which offered to furnish apparatus and tower for $182,600.

JAPAN'S MARVELOUS AEROGRAMS.

A recent press dispatch from San Francisco says: "Across 4,700 miles of ocean, aerograms have been received from Japan by operators in the United States wireless telegraph station in this city. Although they have been unable to reply to the call from over the seas, they have watched with growing interest the efforts of the Japanese to get into communication with the United States through other means than the cables and ships.

"This marks a record for receiving wireless messages. It was nearly four months ago that James Watkins, chief operator, and R. Lawrence McLaurin, the night operator, were surprised one night to catch strange signals from apparently a great distance seaward. Japan, with more powerful sending apparatus than is found in any other wireless station in the world, flashed her signals through almost a sheer 5,000 miles. But Japan does not know her voice was heard and will not until this news is sent to the land of the mikado.

"For weeks and weeks the Japanese had been calling and Operators Watkins and McLaurin heard, but could make nothing of it. Honolulu heard, too, and at the same instant, by comparing notes. The two stations reached the conclusion that the signals came from Japan."

WIRELESS QUERIES.

ANSWERED BY V. H. LAUGHTER.

Spark Coil Design.

Questions.—(A) I would like to know if a 1⅛ inch core, 15 inches long, will be large enough for a spark coil, with eight miles of No. 36 wire in the secondary and two layers of No. 16 wire in the primary. (B) What current in volts and amperes would run same? (C) What size spark would I get? (D) If the core and primary winding are not right, would like to know what to use to get the best efficiency from the coil.—A Reader, Napa, Cal.

Answers.—(A) Yes.

(B) A battery giving 12 volts will operate the coil satisfactorily. Figuring the diameter of single cotton covered No. 16 wire as .055 inches and the average diameter of cylinder wound as (1.125 + .055) 1.18 inches, approximately 146 feet of wire (two layers) having a resistance of .58 ohms is used. $\frac{E}{R}$ or $\frac{12}{.58}$ gives C equal to 20.5 amperes. But a point often misunderstood is that $\frac{E}{R}$ gives a larger current than enters the primary, because a large reduction is made by the self-induction of the primary coil. We can hardly go farther into this question in this department.

(C) About a three-inch spark with a condenser of 150 sheets, 9 by 9 inches.

In Questions and Answers Department, November issue, 1908, see answer

to question (B) of A Reader, Seattle, Wash.

(D) Little data and few formulas and rules are recorded to give the relation between transmitting power, dimensions, and constants for coils. In practice each manufacturer experiments until he finds the conditions necessary for his particular purpose. A closer compliance to what standard data is available, allowing one inch of core to project at each end to reduce magnetic leakage, would be to use two layers of No. 14 wire on the primary and five pounds of No. 33 wire on the secondary.

Four Inch Spark Coil.

Question.—Will you kindly tell how to make a four-inch jump spark coil, with dimensions and size and amount of wire.—J. C. R., Leominster, Mass.

Answer.—Length of core, 14¾ inches; diameter of core, 1½ inches; primary wire, No. 12 B. & S. gauge, two layers; secondary wire, No. 33, ten pounds. Condenser: 200 sheets, 9 by 9 inches; battery voltage, 16. See "Construction of a Two-Mile Wireless Outfit," November issue, for further hints.

Spark Coils.

Questions.—(A) In winding a one-inch spark coil with number 32 wire instead of 36 what will be the difference? (B) Does a telegraph set have to be equipped with a relay and how is the relay used? (C) How much wire is used to construct a gas lighting spark coil? E. F. R., Rahway, N. J.

Answers.—(A) The spark will be reduced in length to a large extent but this will be especially valuable for use in wireless telegraphy.

(B) The telegraph relay is not absolutely essential to a short distance telegraph set but it is a very necessary addition for long distance work. It is used to open and close a local circuit containing a sounder, and is operated by the very slightest current coming in over the main line.

(C) Gas lighting coils are divided into a number of different types and it would be necessary for you to state your question more clearly before we could give you an answer.

Receiving Ability; Detectors.

Questions—(A) From how far would the following outfit receive: Auto-coherer; 1,000 ohm receiver; 60 foot aerial, and tuning coil? (B) Which is the best silicon of electrolytic detector?—K. W. W., Fort Scott, Kans.

Answers.—(A) Up to 50 or 100 miles.

(B) The electrolytic is the more sensitive.

Sending Helix.

Questions—(A) How is a sending helix made and what is the principle? (B) If a one-inch coil is immersed in oil how much current can safely be used with it and what kind of oil should be used?—C. R. K., Little Rock, Ark.

Answers.—(A) The sending helix can be made by winding 10 turns of No. 6 bare copper wire on a frame 10 inches in diameter and 10 inches in height. The respective turns offer a high choking effect to the high tension currents and will allow of a large range of regulation to be had within a short length.

(B) A coil can carry so much current and no more. Immersing the coil in oil would in no way make the primary turns more conductive. However, the better the insulation the more perfect the coil will be from the electrical standpoint.

Condenser; Interrupter.

Questions—(A) Which are the best, Leyden jars or paper condensers on the primary of a four-inch coil? (B) Is it necessary to use Leyden jars in the secondary circuit to fatten the spark for wireless work? (C) Explain the mercury interrupter and how it works? Could it be used with the battery current? (D) Would No. 14 aluminum wire do for use in constructing a tuning coil? (E) Could you tell me the nearest wireless station to Chicago?—F. H., Chicago, Ill.

Answers.—(A) A Leyden jar is the more efficient type of condenser, but for use across the vibrator contacts in the primary circuit, the paper type will answer and is usually employed.

(B) Yes, either a Leyden jar or some other type of high frequency condenser.

(C) Mercury interrupters are of many different types and to describe the various kinds would require more space than can here be given. One of the most common types consists of a vibrating contact operated by motor which works in and out of a pot of mercury. Such interrupters can be used with batteries as well as with power circuits.

(D) Yes, but the size is rather large. We would recommend No. 22 tinned copper wire.

(E) Detroit.

Sensitiveness of Receiving Apparatus.

Question—Would the receiving set described on page 635 of your February issue pick up messages from the commercial stations three and four hundred miles from Cincinnati?—H. S. B., Cincinnati, Ohio.

Answer.—We hardly think that this detector would pick up messages from stations this far away. With a suitable aerial and a liquid detector this would be possible.

Receiving Distance.

Questions—(A) How far should I be able to receive with the following equipment: Zincite and copper pyrites detector, tuning coil, 40 foot aerial, condenser and telephone receiver? (B) What size spark coil is necessary to send up to five miles and how can I make it? (C) Kindly give me the directions for making a 20-mile wireless set.—E. K., Washington, D. C.

Answers.—(A) From 25 up to 100 miles.

(B) We refer you to the article, "Construction of a Two-Mile Wireless Outfit," in the November, 1908, issue, which described a coil that will send up to five miles under good conditions.

(C) A twenty-mile wireless set would constitute a tuned sending and receiving equipment, using a liquid detector and a four-inch coil which will be fully described in the serial on spark coils beginning in this issue.

Condenser and Detector.

Questions—(A) What is the purpose of a condenser? (B) Can the fine wire in a detector be any other than platinum? (C) How can an induction coil be constructed cheaply? (D) What is a coherer used for.—J. N., Wappingers Falls, N. Y.

Answers.—(A) The condenser is used to cut down the static interference, and to a certain extent increases the strength of the received signals.

(B) Other kinds of wire are being employed at the present for special experimental work, but the platinum is to be recommended.

(C) We refer you to the series of articles beginning in this issue under the title, "Spark Coil Construction and Operation."

(D) The coherer is used to detect wireless waves.

Electrolytic Detector.

Question—How many volts are needed to work an electrolytic detector in series with two 75 ohm telephone receivers?—E. I. W., New York.

Answer.—The voltage necessary to operate the liquid detector is exceedingly low. A dry cell giving one volt will answer.

Condenser.

Question—Is a condenser absolutely necessary in a wireless sending apparatus? If so, for what purpose will an ordinary one made from a brass tube answer?—W. G., Chicago, Ill.

Answer.—A condenser is not necessary in the sending end unless the set is of the tuned circuit type. We would not recommend a condenser made from a brass tube for use in the sending circuit. However, it could be used in the receiving side to an advantage.

A. B. C. Receiving Set.

Questions—(A) Can a telegraph sounder be used in place of a receiver in connection with the A. B. C. receiving set? How many ohms should the telephone receiver have? (B) How high should an antenna be to send up to three hundred feet with the one-half inch spark coil? (C) How many dry cells can be used on a one-half or three-fourths inch spark coil?—R. B. McC., Jenkintown, Pa.

Answers.—(A) A telephone receiver only can be used. Any type of telephone receiver will answer.

(B) From 30 to 40 feet high.

(C) Not over four or five should be used.

Telephone Induction Coil.

Questions—(A) I have a battery telephone coil and would like to know if it could be used in connection with wireless telegraphy. (B) I have two coils that belong on an electric light tester. Would these be of any use? (C) What would be the distance a ¼ inch spark coil could send messages if connected with a 50-foot aerial?—J. L. D., Cambridge, Mass.

Answers.—(A) The coil you have on hand would be useless in wireless telegraphy. It is too small to try to change it into a spark coil and too large for a receiving transformer.

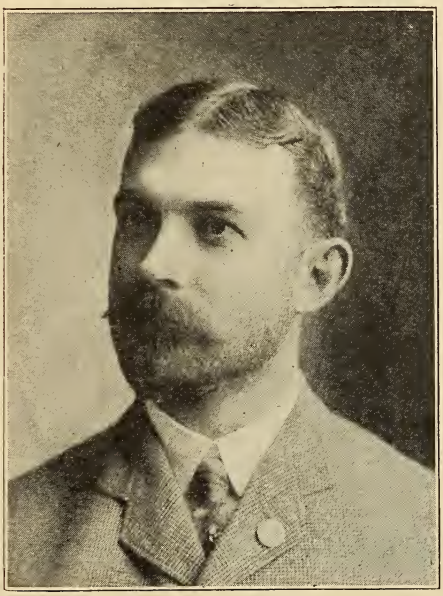
(B) No.

(C) Up to one-fourth mile under good working conditions.

ELECTRICAL MEN OF THE TIMES.

HENRY L. DOHERTY.

A pioneer exponent of the "new business idea" in electric central station practice is Henry L. Doherty of New York. To be so identified with a movement of the most far-reaching benefit to the central station business might well be cause for great pride on the part of any man. But no man, perhaps, can "stand prosperity" and the praises of his fellow men better than Mr. Doherty. He is unspoiled by success, for he has a level head.



Henry Latham Doherty was born in Columbus, Ohio, in 1870. His education was of the self-acquired variety and most practical in its nature. When twelve years of age he entered the employment of the Columbus Gas Company and remained there, in various capacities from office boy upward, until 1896, when he went to Madison, Wis., as manager of the Madison Gas and Electric Company.

In 1897 Mr. Doherty became a member of the National Electric Light Association, at that time devoted to technical work, and at best rather an easy-going institution. It was Mr. Doherty's idea that such an association should be more than a mere body for the discussion and preservation of data and records of physical developments. He believed that it should be made a moral force to sustain its members in their efforts against competition and to devise new ways and means for educating the public in the use of electricity and to assist the central stations in their plans to secure new business intelligently. His efforts in the association did not at first meet with favor, for he was young and the older members rather resented his aggressiveness. But he gradually found supporters until finally, in 1901, he was elected to the presidency of the association, and from that day its real success began. With one bound Mr. Doherty became practically dictator of the organization and indisputable leader of the majority, and the mandates that were issued by the association became assertive and forceful.

The story of Mr. Doherty's work in Denver, where he placed the Denver Gas and Electric Company on a sound basis, raising it from the position of a heartily despised corporation to that of a subject of great municipal pride, is well known, and has been told in a previous issue. But this is only one example out of many instances in which he has rehabilitated the affairs of a broken down light company and made it a potent factor in the upbuilding of a city. As a result he is now the moving spirit in a large number of lighting companies throughout the country.

All through his successful business career Mr. Doherty has been a firm believer in advertising for the building up of central station business. And his conception of advertising is by no means a narrow one, but a great, broad gauge plan whereby the people are brought to know of the advantages and economies of electric current through systematic educational campaigns, through public and private demonstrations, newspaper advertising, direct advertising, lectures, electrical shows and expositions, and a hundred and other ways which his able lieutenants might devise.

ELECTRICITY IN THE HOUSEHOLD

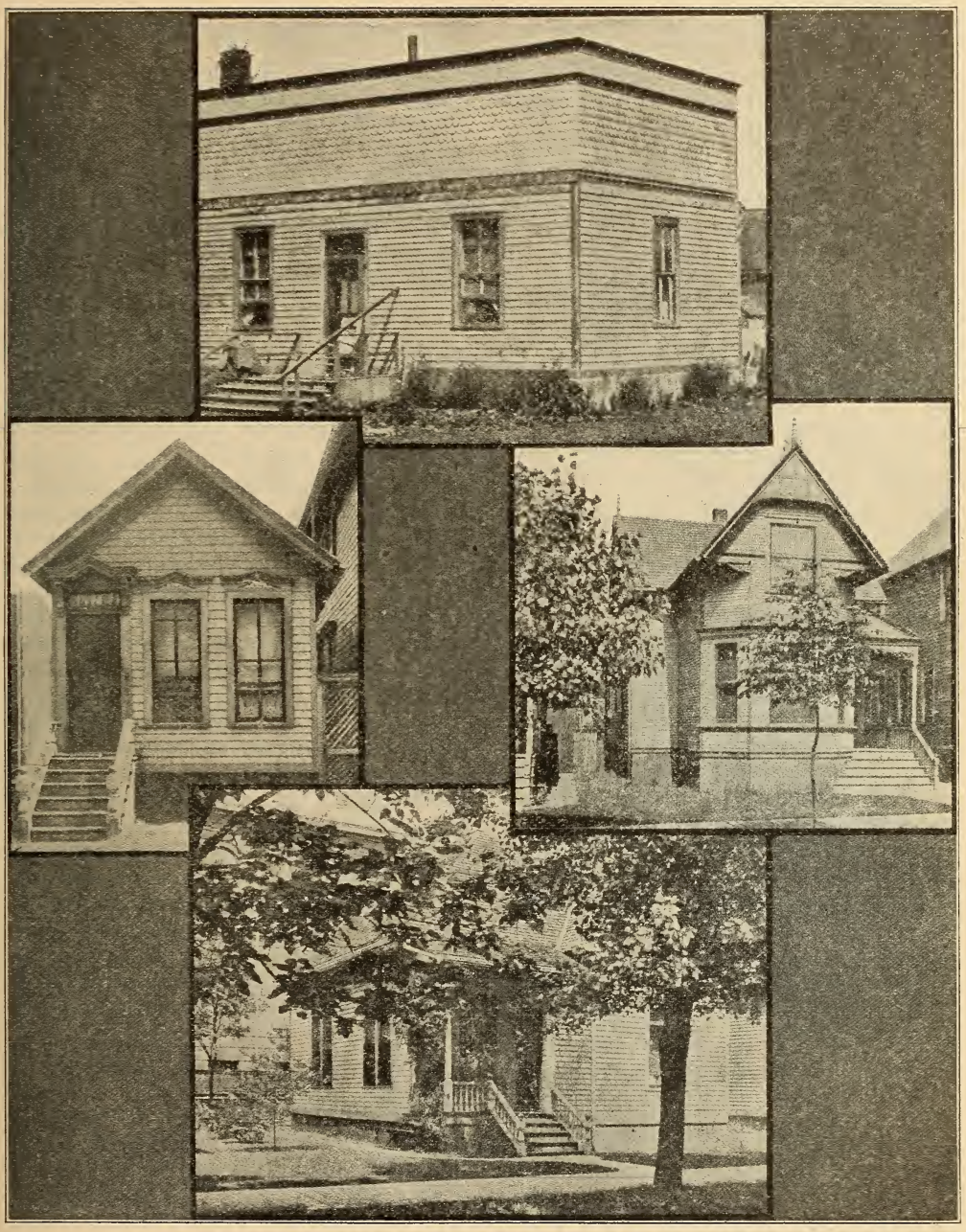
IS ELECTRIC LIGHT TOO DEAR FOR MODEST PURSES?

BY WILLIAM KEILY.

"Give a dog a bad name and hang him," is an old saying, and it is exemplified by the fact that many persons still labor under the delusion that the cost of electric lighting in the home is so high as to be prohibitive to all except the well-to-do. It is not strange that this is the case, for in the early days, and up to say 10 years ago, the ideal illuminant was, indeed, comparatively expensive, and its use for residence lighting was urged on the undeniable ground of quality rather than price.

People generally do not realize, however, the really wonderful development in the art of producing and marketing electricity which has been made in the last decade. The improvement is not only in the design of electrical machinery, to prevent losses; not only in betterment of the means of transmitting the current, for the same purpose; not

IN EVERY HOUSE ON THIS STREET ELECTRIC LIGHTS AND FLAT IRONS ARE IN USE.



THESE ARE MODEST HOMES. EVERY OWNER FOUND ELECTRICITY NOT ONLY CONVENIENT BUT AN ACTUAL ECONOMY.

only in the use of high-efficiency lamps and reflectors, which produce two or three times as much light for the same consumption of current; not only in the remarkable economies effected by modern prime movers (the machines which drive the generators of electricity), such as steam turbines and gas engines; not only in the greatly extended use of waterpower—but more than all these causes, even, the change is due to the education and enlightenment of the electric-light man himself.

The average manager of a public elec-

tric-lighting plant is no saint. He is just a "hustling," hard working American business man who is trying to get the best possible return from the property in his charge. But he takes a broader, more serious view of the relation of a public-service corporation to its public than he once did. He strives to please the people, not to antagonize them. And in selling electricity he has discovered that it pays best to produce his product in large quantity to secure the advantage of low cost of production; to sell large quantities to attain the heavy load on the station which this policy makes necessary, and to sell at low price to secure the big demand.

This may seem to be a self-evident business proposition, but in the central station industry it is not so simple as it appears. There are troublesome questions of "load factor," interest charge on idle machinery, "maximum demand," "readiness to serve," extensions of lines (especially important where only underground construction is permitted), cost of customers' meters, cost of house wiring, etc., which cannot be gone into here, and these make the fixing of equitable electric lighting rates a perplexing problem indeed. But the general tendency, as the men and methods in the electric lighting business improve, is toward cheaper prices. In Chicago, for instance, the rates for electricity are now only about 40 per cent what they were 10 years ago.

At 10 cents a kilowatt-hour electricity is considered to be about as cheap as gas for lighting, and in many places electric energy can be bought, even by the small consumers, at a lower price than this. Often there is a primary rate higher than the figure given and a secondary rate considerable lower, and the cottage or small-apartment customer can secure the advantage of the lower rate by a wise use of his lights, which the central station company will be glad to explain to him, for it enables the company to make a better use of its facilities and to stand ready to serve more customers. Sensible co-operation between customer and company is mutually advantageous.

In many small towns there are no gas plants, and here the electric light competes with kerosene lamps. This is true too in workingmen's homes in larger cities. Electricity has proved itself able to meet this challenge, and in households where every cent counts. One reason for this is that of late years kerosene oil has constantly risen in price, while electricity has decreased. Another is that the labor and inconvenience of keeping up the oil supply and filling and cleaning the lamps is to be added to the cost of the oil.

Four rather haphazard examples of what is actually being done in supplying electricity to the homes of people of scanty or moderate means under commercial conditions in towns and cities in the Middle West may be given. It is to be noted that in every case the current sold is generated by steam power.

In Cadillac, Mich., the central station company has 300 customers on its books (or had last August, when the statement was made publicly) whose wages do not exceed more than two dollars a day. These workingmen can afford electric light and the company can afford to sell it to them, or of course it wouldn't do it. The company gets from $9 to $15 a year from each consumer of this class.

Dubuque, Iowa, has an up-to-date electric lighting management, and here a carefully prepared educational campaign has been carried on to convince householders of moderate means that electricity is not to be regarded as a luxury for the rich. During the last eight months more modest homes have been equipped electrically than during any previous period of several times that duration. Here it is found that the possibility of using the electric flatiron is a great attraction toward the electric service. Where housewives do their own ironing, they find the electric flatiron a great labor-saver. It is significant that in East Dubuque, a small suburban village of workingmen's houses, there is proportionately more residential lighting (electrical) than in prosperous Dubuque, across the river.

Residence lighting has always been an important branch of the business of the electric lighting company in Detroit, which is to be expected, perhaps, in that city of beautiful homes. The rapid growth of the business, however, dates

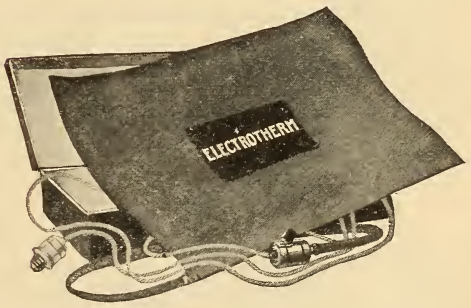
only 10 years back. Now there are over 12,000 residence customers of all classes. In this city a large number of cottages as well as more pretentious houses are electrically lighted. This business is taken from kerosene competition. Usually the cottage householder who uses electric light in Detroit owns his own home. This city has many districts consisting of rows of small houses, called terraces, where each cottage is owned by its occupant. Such owners prefer electric light because of the saving in maintenance of wall decorations and ceilings. Several large property holders specify in their rental leases that electricity shall be used exclusively for lighting by the tenants. This policy was adopted without action on the part of the central station company. The average monthly bill for residence electric lighting in Detroit is $2.32.

Chicago has about 30,000 householders living in small houses or apartments who are customers of the electric lighting company. In an ordinary seven room apartment perhaps 20 lamps will be installed, although the number varies to suit individual requirements. Formerly a minimum monthly payment of one dollar was required, but this is no longer asked, and many bills are made out for less than that sum. But, taking the general run, the monthly cost of electric light in the small homes of Chicago may be said to range between $1.15 and $2.50 net. There has been a great increase in this class of business within the last few years, stimulated by steadily decreasing rates for electricity.

Of course the price of electricity varies widely in different localities, affected by local conditions. Some managements are less anxious for residence business than others. Some, using the "white coal" of waterpower, are able to sell electrical energy more cheaply than others who have to burn coal hauled perhaps a long distance. The prevailing rate of interest on money, cost of labor and several other things, such as the character of the community served, whether industrial or otherwise, all have their influence on the commercial price of electricity to small residence users. But it is believed that the facts and figures given in the dispassionate survey of the situation made in this article show that, in most places, the man who can afford to pay from 75 cents to $2.50 a month for the lighting of his home can have the use of electricity, with its great advantages of healthfulness, cleanliness, cheerfulness and convenience.

THE ELECTROTHERM.

The Electrotherm is a light, flexible pad composed of wires insulated and protected with asbestos and designed to perform the function of the old-fashioned hot water bottle. It is arranged for attachment to an ordinary electric light socket, and when so connected, the pad offers sufficient resistance to the current to produce a constant and absolutely uniform degree of heat as long as the current is turned on. A regulating switch

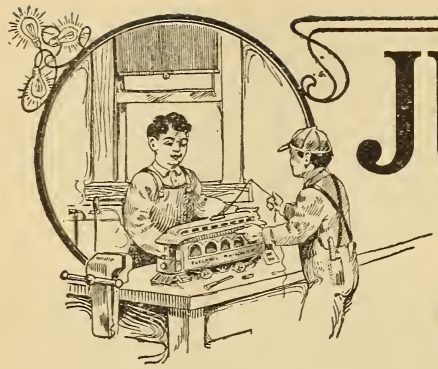


THE ELECTROTHERM.

is provided by which a low, medium or maximum degree of heat may be obtained at will, by simply turning the key.

In pneumonia cases the value of the Electrotherm is especially apparent for the reason that the most potent influence in the treatment of this disease is bodily application of a steady, continuous heat.

In consequence of resulting danger from the disturbance of the patient, and the change in temperature caused by changing the application when a hot water bottle is used, physicians have reluctantly been compelled to forego this most efficient influence. In such cases the Electrotherm is indispensable, obviating as it does, all these objections and furnishing the only method for an application of a regulated heat for an indefinite period.



JUNIOR SECTION

CONSTRUCTION OF A LAMINATED MOTOR.

BY MILFORD J. WHINNEY.

I have constructed the electric motor here described, and have found it to work admirably. It is a unique little machine embodying as it does a laminated field and armature.

The field piece and armature are built up of 30 sheet iron pieces. The material for this purpose may be obtained from a tinsmith, or by heating old tin cans until the solder melts, when they may be pulled apart and straightened into flat sheets, as the so called "tin" of which cans are made is simply sheet iron coated with tin, and will answer the purpose. Carefully lay out an armature disk, the shape and size shown, Fig. 1. In one of the sheets, punch a small hole accurately in the center and enlarge by reaming with the tang of a file until a one-eighth inch wire nail can just be forced into it. Cut out the disk carefully with an ordinary pair of scissors, and file off any burr that may remain around the hole. Use this as a pattern for laying off the remaining 29 pieces.

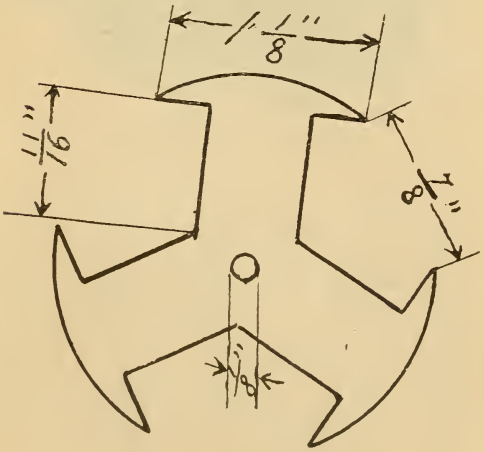


FIG. 1.

Having cut 30 pieces, now bind them together with twine, to hold them in place until the wire is wound on. Turning now to the field magnet, Fig. 2, lay off as per drawing and cut 26 pieces as shown by the solid lines and four pieces with the extensions shown by the dotted lines. These extensions are afterward bent out at right angles and form ears for securing to the base-board.

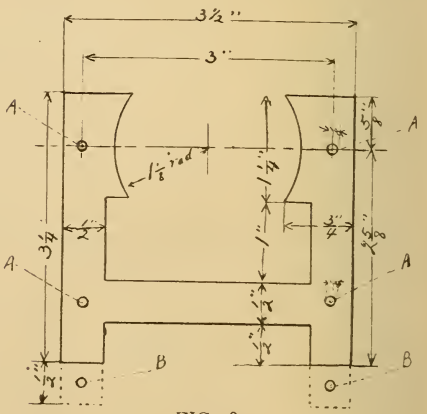
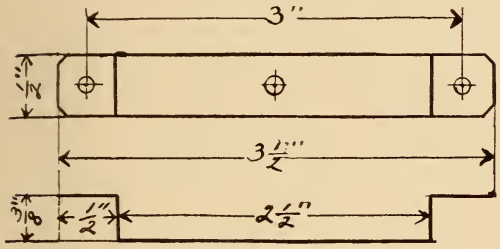


FIG. 2.

Assemble the sections of the field by putting two pieces with the extensions, on each side of the 26 pieces, then clamp the sections in a vise and drill four one-eighth inch holes in them at (A, A, A, A), Fig. 2; also drill a one-eighth

inch hole in the extensions at (B, B). The field sections are now bolted together with four small one-eighth inch bolts passing through the holes (A, A, A, A).

The bearings, Figs. 3 and 4, are cut from heavy sheet brass. The holes for



FIGS. 3 AND 4.

the armature shaft should be of such a size as to allow it to revolve freely but with no shake. The holes in the ends are the same diameter as those in the field pieces, one-eighth inch.

The armature is assembled by forcing the disks onto the shaft, Fig. 5, which is

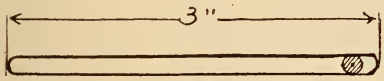


FIG. 5.

made from a wire nail one-eighth inch in diameter and three inches long, the head having been cut off and the ends nicely rounded.

The commutator is made of a piece of wood as shown in Fig. 6, the hole either being drilled through or burned

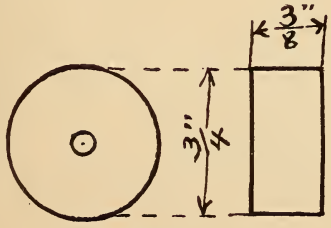


FIG. 6.

with a red-hot wire so that it is a tight fit on the shaft.

The commutator segments, Fig. 7, are cut from thin sheet copper or brass and fastened to the wooden cylinder by bending down the lugs. Leave about one-sixteenth of an inch between each segment.

The brushes are cut from the same sheet copper or brass as in Fig. 8, and are fastened by small screws to the brush holder, a wooden block made to

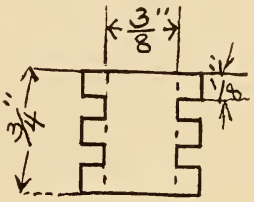


FIG. 7.

the shape and size shown in Fig. 9.

Now wind the field magnet with about one-half pound of No. 18 gauge single cotton covered magnet wire, first wrapping a layer of writing paper around the

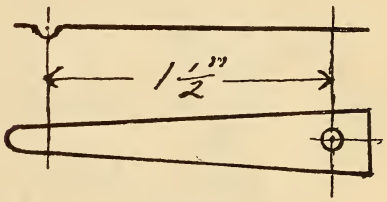


FIG. 8.

sharp corners. Five layers of wire are enough, and a free end three inches long should be left at the beginning and end of the winding for connections, one end

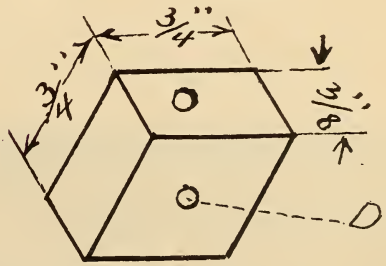


FIG. 9.

is connected to a binding post and the other to the lower brush when the motor is assembled.

Having finished winding the coil, cover it with one layer of adhesive tape, as this helps to protect it.

Wind the armature as shown in Fig.

10, first wrapping on a layer of paper. Wind each pole with four layers of No. 22 single cotton covered magnet wire, winding always in the same direction. Connect the inside layer of one winding to the outside layer of the next, continuing thus until there are three connections, each consisting of two wires (A) and (B), Fig. 10, which must be scraped for a distance of about one inch from the ends and twisted together, as shown at (C). Then connect the three twisted ends, one to each of the three segments of the commutator, by a drop of solder.

Then assemble the motor by fastening the bearing strips to the field with the small bolts passing through the holes (A, A, A, A), Fig. 2, also put a few washers or short coil of bare copper wire

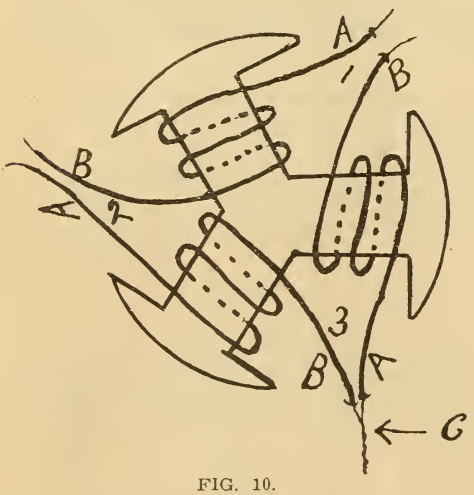


FIG. 10.

on the shaft to keep the armature in place between the pole pieces.

The brush holder, Fig. 9, is fastened to the front bearing, Fig. 3, by a small bolt passing through a hole made in the bearing, and one made in the wood block at (D), Fig. 9.

Having assembled the motor and properly connected it the circuit will be through the field coil to the lower brush, then through the brush and commutator segment around the armature, out through the opposite segment and brush to the battery.

Two cells of battery will run the above motor at a good rate of speed, but with a few more cells more power may be obtained.

COST OF OPERATING ELECTRIC APPARATUS.

Experimenters who use electric light current often desire a means of determining the cost per hour of operation of a certain piece of apparatus. If direct current is used, this is a simple matter, since direct current ammeters, as are used for batteries, are cheap and easy to procure. But alternating current ammeters are expensive and complicated, and therefore not available in modest laboratories. Happily there is a way, used by the writer, by which the cost of alternating current may be determined, and which does not require any extra apparatus. It is by means of the lighting company's meter.

All, or nearly all, alternating current meters have an opening in front, under the dial, through which the armature or rotor may be seen. This rotor makes a certain number of revolutions per minute in proportion to the amount of current used, and when no current is being used by the consumer, the rotor is stationary.

First of all the number of revolutions per minute that the rotor makes when a known current is being used must be counted; then the apparatus, the cost of operation of which is to be determined, is connected up, and the revolutions per minute of the rotor counted again. The ratio of the speed in the latter case, to the speed in the former, is the same as the ratio of the two costs, and since the cost in the former case is known, that in the latter may be computed.

To give a particular example. The writer's meter, a five ampere integrating watt-meter, has a rotor which makes four revolutions per minute when one 16 candle-power lamp is burning. Since a 16 candle-power lamp costs one-half cent per hour (at the rate here prevailing), taking one-half ampere at 110 volts, those four revolutions per minute correspond to one-half cent per hour. When a small motor was operated, through resistance, on the 110-volt current, the rotor of the meter made twenty revolutions per minute. The ratio of speed was twenty to four, or five to one, and since this is the ratio of cost, the current cost five times one-half cent per hour or two and one-half cents per hour.

LOUIS H. ROLLER.

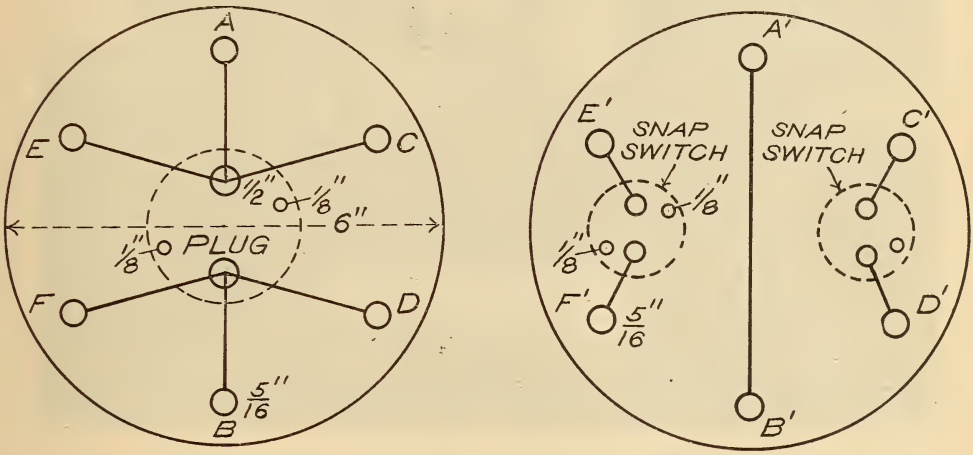
HOME-MADE ELECTRIC HEATER.

BY P. J. O'GARA.

A home-made electric heater which is nearly as efficient as a factory made heater may be constructed by any ingenious boy. The material necessary for its construction is not expensive and only a few tools are needed.

Procure six porcelain bushings 18 by 13/16 inches and wind each one with 25 feet of No. 26 "Climax" resistance wire. The turns should not be allowed to touch each other, and may be kept apart by putting on a thin coat of plaster of Paris on one side. It is not necessary to entirely cover the wires with it. Cut out two disks of tin or other thin sheet metal six inches in diameter, and punch six 5/16 inch holes at equal distances and within ¾ inch of the outside edge. Also punch holes through which to lead out the wires, as well as others for the attachment of the plug and snap switches. Then cut out two disks of asbestos the same as the metal disks. The diagram of these disks is shown in Figs. 1 and 2. Cut off six lengths of 5/16 inch rod iron 20 inches long and thread these lengths at both ends for about one inch. Then assemble the parts as shown in Fig. 3. The attachment plug is shown at the right while the two snap-switches are at the left. The terminals of the three upper coils should now be brought out and fastened under the upper contact of the plug; and the three lower terminals should in like manner be brought out to the lower contact screw. The upper and lower coils should have their other terminals connected together right across the end. The nearest pair of coils should now have their left hand terminals connected to the snap-switch; and the farther pair should in like manner be connected to the other snap-switch. With this arrangement three heats may be obtained by turning the snap-switches on or off.

After the plug and snap-switches have been connected with the coils, two tin disks the same diameter as the other disks are fitted over the ends and held in place by small machine screws. These are not absolutely necessary, but they cover up the nuts which hold the parts together, making the apparatus have a more finished appearance. Cut a piece of asbestos just long enough to fit in between the two heads, and wide enough to just cover the three lower coils. This



FIGS. 1 AND 2. ARRANGEMENT OF PLUG AND SNAP SWITCHES IN ELECTRIC HEATER.

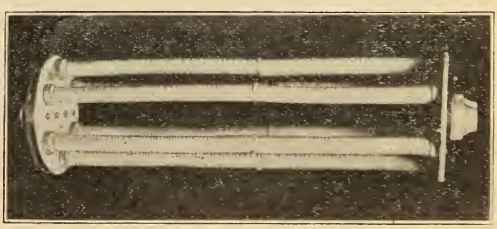


FIG. 3. HOME-MADE ELECTRIC HEATER.

is necessary in order to protect the floor from excessive heat, since the heater rests in a horizontal position. As shown in Fig. 4, a protective covering made of a piece of perforated sheet metal

total capacity. Attachment is made to the ordinary lamp socket by means of a piece of lamp cord and a plug.

In case that it is desired to wind the heater for 220 volts, each coil should be

FIG. 4. ENJOYING THE COMFORTS OF THE ELECTRIC HEATER.

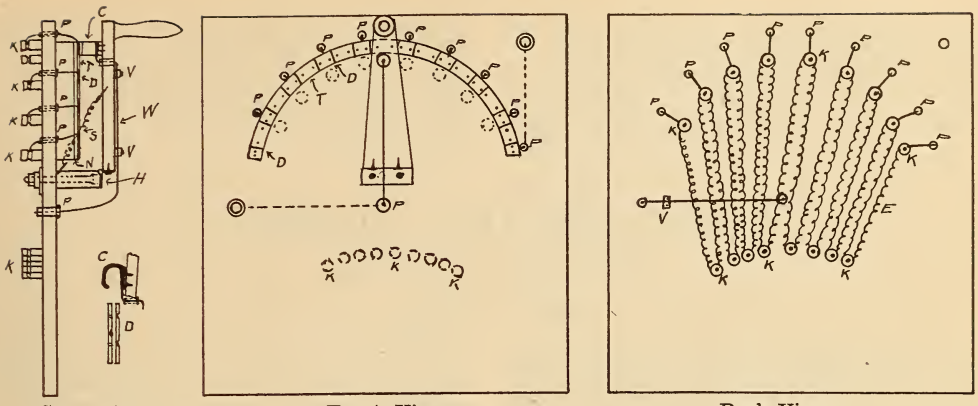
20½ inches long and 19¼ inches wide is now fitted over the coils, and held in place by the bolts which also attach the legs to the heater. The legs are made of ⅛ inch strap iron bent into the form shown in Fig. 4. Since the bolts, which attach the legs to the cover, also pass through the bottom sheet of asbestos, there is no chance of the coils slipping out. In case the perforated sheet metal cannot be obtained at a hardware, store there are always discarded sheets to be found at a flour mill, where perforated zinc screens are used for milling purposes.

This heater is constructed for a voltage of from 110 to 120, which is the ordinary voltage of most incandescent lighting circuits. When turned on full the heater consumes about 600 watts, or that of 12 incandescent lamps. With the two snap-switches turned off, it takes about 200 watts, or one-third the

wound with No. 29 "Climax" resistance wire having the same length as before.

GENERAL PLAN FOR A HOME-MADE RHEOSTAT.

This rheostat can be made by anyone having a few carpenter's tools. The frame and fittings may be varied to suit the current regulated, and worked out in accordance with the plans. A hardwood panel of the required size lined with ⅛-inch asbestos on the back should be provided to support the resistance coils (E). The panel should be mounted 12 inches from the wall on metal brackets. All screw heads should be countersunk. The following material is needed: Porcelain knobs (K); porcelain bushings or loom (P); strip of ¼-inch asbestos (N); ¼-inch asbestos board (T); two copper plates (D), ⅛-inch thick; strong steel spring (S); common door hinge (H); copper straps (C);



Side View. Front View. Back View.

GENERAL PLAN FOR HOME-MADE RHEOSTAT.

porcelain cleats (V). Enough hardwood should be provided to construct the revolving part under hinge (H), the arc of the circle for contacts (D), and the arm and handle.

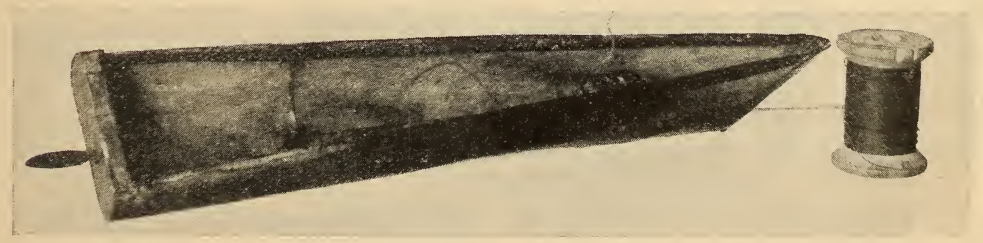
As seen in the back view, the distance between the upper and lower knobs (K K) may be increased or diminished to provide room for the necessary wire resistance. When the arm is on the contact (D) the circuit is open. The arm should have a hardwood peg as a stop at starting and running positions and also an additional peg to hold the arm in the running position. This part of the device may be arranged to suit the ideas of the builder.

Eight steps are provided in cutting out the resistance. Use Ohm's law, $C = \frac{E}{R}$ to determine C at each step, E and R being known. For convenience in figuring wire resistance, it may be noted that the resistance of copper wire is 10½ ohms per circular mil foot; iron wire, 6 times as much; nickel, 8 times, and German silver, 13 times as much.

SMALLEST ELECTRIC LAUNCH.

Probably the smallest electric launch ever constructed is the one shown in the picture. It is the handiwork of a boy 18 years of age, John Elliott Jenkins, of Chicago. Young Jenkins is studious almost to the extent of being retiring, and is never so happy as when let alone and allowed to satisfy his craving for electrical experimental work. He has constructed a great many ingenious devices, but the electric launch is the most skilfully executed of them all.

The launch is 7½ inches long, with a 1⅝-inch beam and a depth of 1¼ inches. The picture shows its size as compared with an ordinary spool of thread. It is made principally of shellaced paper, with a few little bits of wood here and there for stiffening. The propellor shaft is part of a hat pin, with tiny blades care-



SMALLEST ELECTRIC LAUNCH.

fully mounted, and this shaft is driven by a most curious little motor only three-quarters of an inch high and with wires almost as fine as hairs. The armature of this motor is about half as big as a good sized hazlenut. But for all this, the boat will run, although it is so small that it cannot carry its own battery, unless a very small special one be built for the purpose.

SWITCHBOARD STORIES.

WHY HARVEY MOVED.

BY C. TUELLS.

Harvey Jackson was truly in love with his work. He had just completed his college course of four years at one of our eastern universities, and was now starting in to get his practical experience in the largest electrical manufacturing concern in the world, where he was receiving the munificent sum of 18 cents an hour. Eighteen cents an hour did not seem much to Harvey after his brilliant years at college, especially as it was coupled with 10 hours a day of steady and sometimes very hard work. But experience was what Harvey was after and he was getting it every hour—with the 18 cents an hour thrown in.

THE WIRE TAPPING WAS A GREAT SUCCESS.

The city of Lynn wasn't a large city, consequently Harvey experienced little trouble securing a room in the center of the business section, still keeping financially within his limited means. His first months of experience were spent in the arc lamp department of the manufacturing concern where for a while he was kept busy breaking up old lamps, after which he went to the testing bench and later up to the experimental room. The experimental room was a veritable wonderland to Harvey and it was not long before his inventive genius began to crop out. His time at the shop was mostly taken up with routine work, but he used to spend his evenings developing his new ideas in his little down-town room, which was located directly over the largest dry-goods store in town.

One day at the shop, while Harvey was trying out an experimental lamp, he conceived the idea of making a style of lamp that would use less current and give much more light; so that evening in his little room he started in to investigate his idea. With the aid of some old lamp parts and the shop scrap-barrel and a few evenings of persevering work he had his model lamp completed and all ready to test, but, blinded by his enthusi-

asm, he had overlooked the fact that an arc lamp could hardly be a success on a low voltage and much over-worked incandescent circuit, so, though his lamp was now ready, it was useless unless he could get a higher voltage circuit on which to try it out.

Dejectedly he sat looking out of the window, thinking how his success was being nipped in the bud, when his eye caught the series arc light wire directly under and within reach of his window. There is an old adage that reads, "Fools rush in where angels fear to tread" —Harvey tapped the wire. The tapping was a great success, mechanically if not morally, and the brilliant rays from his highly successful lamp completely drowned his guilty conscience. It was necessary for him to keep his blinds closed so that the intense light would not attract attention from passers-by in the street below, but that was easily done, and for many nights he experimented with and perfected his new idea.

One pleasant Saturday evening soon after his invention was developed he was trying to still further increase the efficiency of his lamp, when suddenly (to this day Harvey can't explain how) he accidentally opened the circuit or else grounded it.

Harvey's room was immediately plunged in darkness; so also was the whole street traversed by that particular line. Some one immediately sent a rush call to the electric light company and soon the emergency wagon was thundering down the street towards the dry goods store—and Harvey. The young inventor began to figure how things were coming out and hastily threw open the window and started to disconnect his tapping wires, but he was just in time to be too late, for, as he was removing his second wire a vigilant lineman spied him as he pulled it into the window.

It didn't take Sherlock Holmes' power of deduction to trace the trouble to Harvey's room by way of the window, and soon a store manager, a lineman and a policeman were having an extremely personal interview with a much embarrassed young man, which resulted in his paying a twenty-five dollar fine in the local court next day, and indirectly in the appearance of a sign in the fatal window which read—"To let."

LYNN MARSH, THE BOY TELEGRAPHER.

At 11 years of age Lynn Marsh is one of the best telegraph operators along the line of the Baltimore & Ohio South-Western Railroad. He has been handling the key ever since he was nine years old. He isn't in charge of an office, but his father, W. W. Marsh, is the agent and operator at Winton Place, and Lynn often "sits in" for his father, handling the key like a veteran.

"I started to learn telegraphy when I was nine years old and I expect to be the best telegraph operator in the country

LYNN MARSH AT THE KEY.

when I grow up," declares the youthful knight of the key.

The boy operator is known by nearly all the telegraph operators along the line of the railroad and they all like to take "stuff" from the key of the young expert. Lynn has worked a newspaper wire for an eight-hour turn, but he prefers the click of the railroad message to that of the newspaper story.

The war department has confirmed the report that ex-President Roosevelt is carrying to Africa with him two rifles whose sights are equipped with small electric lights to enable accurate shooting at night. These sights are the invention of a Chicago man, and are at present undergoing an exhaustive trial by the war department.

QUESTIONS AND ANSWERS.

Readers of Popular Electricity are invited to make free use of this department. Knowledge on any subject is gained by asking questions, and nearly every one has some question he would like to ask concerning electricity. These questions and answers will be of interest and benefit to many besides the one directly concerned. No consideration will be given to communications that do not contain the full name and address of the writer.

Electrolysis of Water.

Questions.—(A) Is there any definite way to figure the amount of hydrogen gas liberated from water by a known current of electricity? (B) What voltage is the best for the decomposition of water? (C) How are the oxygen and hydrogen gases carried off and compressed? (D) Will you show how such apparatus may be constructed? C. C. V., Pittsburg, Pa.

Answers.—(A) One ampere-hour will set free 12.8 cubic inches of oxygen and 16.3 cubic inches of hydrogen.

(B) Water slightly acidulated with sulphuric acid decomposes with the application of three volts. The real decomposition of pure water has been found to begin at 1.08 volts.

(C) The generated gas may be carried by pipes into a bell receiver having the lower end immersed in water similar to the storage tanks used by illuminating gas companies. The bell may be weighted to secure the desired pressure. Pipes leading to the bells should be equipped with stop valves.

(D) Many different apparatuses particularly of German make have been patented but we do not know of any large plant in commercial operation in this country. We are informed that two or three plants are in operation in Europe. Apparatus for laboratory purposes is shown in Fig. 1, and consists of a glass U tube and a rubber connection to the reservoir (R). By raising and lowering (R) various pressures of (H) and (O) may be obtained. The electrodes (P P) are of sheet platinum. The leading-in wires are of the same metal. The liquid used should be by volume, six parts of water and one part sulphuric acid. This will produce oxygen rich in ozone. The above apparatus or similar outfits are sold by firms supplying schools and colleges with laboratory material. Figs. 2, 3 and 4 give a general design of a commercial outfit said to have been successfully operated in Germany. The whole resembles a filter press. In the designs, (E) is a lead plate acting as a double electrode, (D) is sheet asbestos forming the electrode

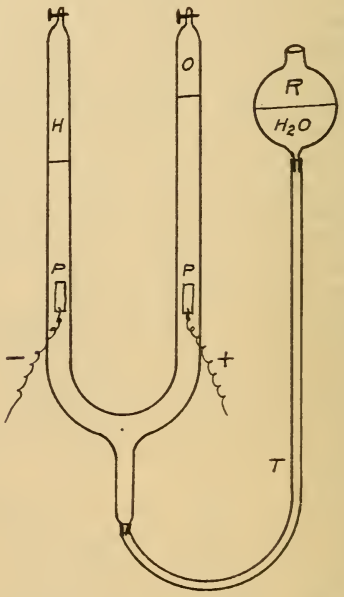


FIG. 1. LABORATORY WATER ELECTROLYZER.

spaces, and at the point where the lead plates would come in contact pieces of rubber are laid on the asbestos. Supply pipes should be of iron or lead with couplings and cocks of bronze. The whole apparatus must be well insulated from the ground and from metal connections to gas pipes. Tests to determine this should be made. The pipes (H) and (O) run to their respective electrode chambers, (H, H, H) and (O, O, O). Each plate, Fig. 4, has at the top and bottom in its thick edges, two holes, (H, O) and (W, W_1). The water pipes connect with the funnel supply. Plates, rubber sheeting and asbestos are held together by a hand wheel device shown in dotted lines. Every alternate plate respectively is connected to the +

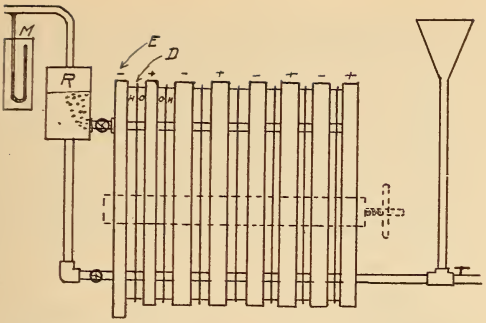


FIG. 2. WATER ELECTROLYZER—SIDE VIEW.

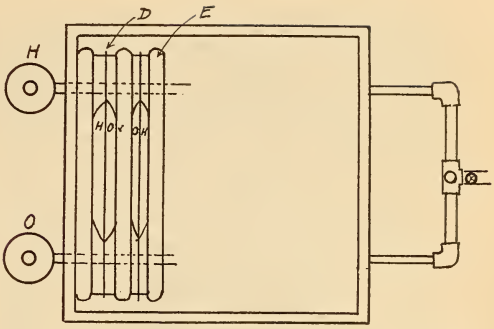


FIG. 3. WATER ELECTROLYZER — TOP VIEW.

and — side of the supply circuit by connections which should be provided but not here shown. Pressure in both leading-off pipes should be kept the same and manometers (M) placed as shown.

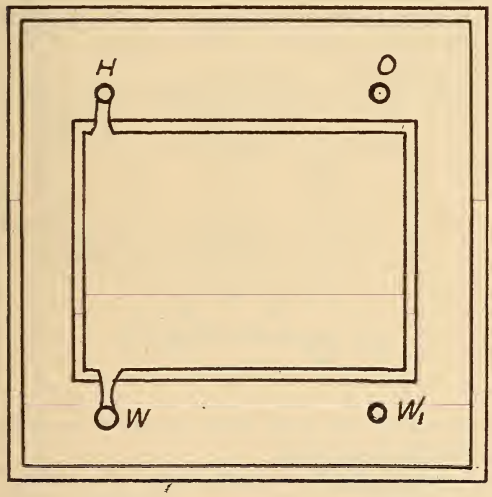


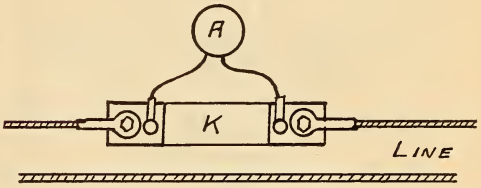
FIG. 4. SINGLE ELECTRODE OF WATER ELECTROLYZER.

The gas when used for medical purposes may be purified by passing it through a red hot porcelain tube. The purity of the gas may be also tested by leading a little of it through a rubber tube into a test tube filled with water and inverted in a dish of water. As soon as gas has displaced the water a match may be lighted under the mouth of the tube. Hydrogen burns quietly. Oxygen should not ignite. If the apparatus takes too little current, test the voltage between the plates. If a chamber shows no pressure a short circuit may have occurred. If the voltage is high the chambers may be empty, possibly by stopping up the channels.

Ammeter Shunt.

Question.—How are ammeter shunts calculated?—F. F., Milwaukee, Wis.

Answer.—The diagram shows the connections for a shunt ammeter. (K)



AMMETER SHUNT.

is a conductor in series with one side of the line and having a low temperature coefficient. Hence the drop in voltage across (K) is proportional to the current passing. (A) is a low reading sensitive voltmeter which measures this drop. If the resistance of (K) is .002 ohms and the instrument reads .5 volts, by Ohm's law $C = \frac{E}{R}$, or $\frac{.5}{.002} = 250$ amperes. Shunts and ammeters are built to measure certain maximum currents and are so named.

Telephone Receiver Wire.

Question.—How much and what size wire should be used to wind a telephone receiver pole?—E. A. R., Rockford, Ill.

Answer.—The resistance of a single pole receiver is about 75 ohms. Use 180 feet of No. 36 B. and S. gauge, or 114 feet of No. 38 single cotton covered wire. In double pole receivers the resistance of each coil is about 50 ohms for each coil. Use 120 feet of No. 36 wire or 75 feet of No. 38 wire.

Transformer and Motor Connections.

Questions.—(A) Please give diagram for connecting a three-phase alternating current motor to service, the primary being 2,200 volts and the secondary 110 volts. (B) How many transformers should I use?—W. C., Sulphur Springs, Ark.

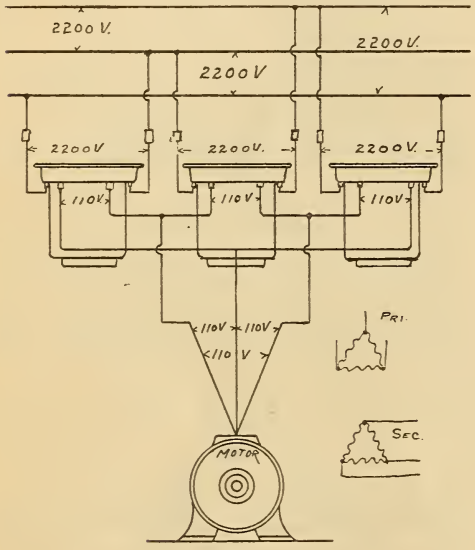


FIG. 1.

Answers.—(A) In making the following calculations it has been assumed that the ratio of transformers in all three diagrams is 20 to 1. The connections shown in Fig. 1 are more commonly used than any of the others. The primaries as shown are delta connected. The pressure in the primary of each transformer is the same as the pressure on the mains, and the secondary pressure is one-twentieth of this. By this method it is plainly evident that if one transformer blows its fuse or breaks down, the other two will be able to carry the load with safety if it is reduced somewhat.

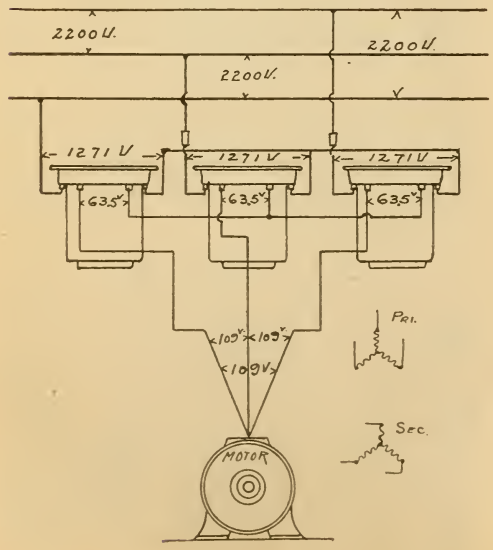


FIG. 2.

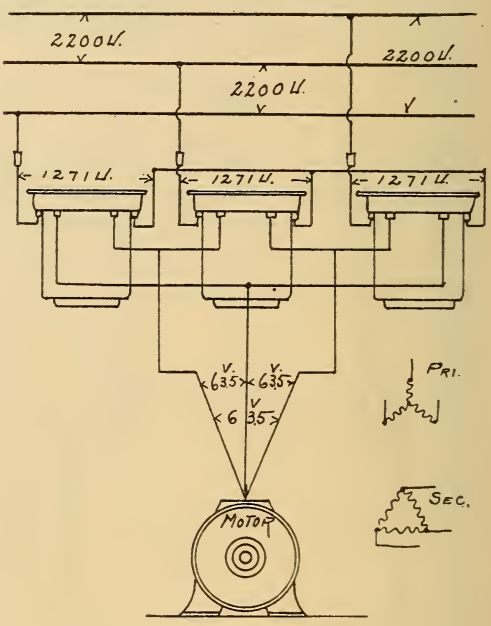


FIG. 3.

In Fig. 2 the primaries and secondaries are Y connected as shown. In this method the voltage in the primary of the transformer is the voltage of the mains divided by the square root of 3 or 1.73. The pressure across the secondary main equals the pressure of the secondary of one transformer multiplied by 1.73. The advantage of this way of connecting is that the voltage across the primary coils is less than the line voltage, which is a very important consideration in the matter of insulation when transformers are connected to very high voltage mains. The same advantage is gained also when the connections are made as shown in Fig. 3.

(B) The number of transformers shown in each diagram answers your question.

To Make a Commutator; Switchboard Connections; Lightning Arrester.

Questions.—(A) How would you make commutator segments for a small dynamo? (B) Will you give diagram showing how to wire a generator switchboard? (C) where and how are lightning arresters connected to outgoing lines? W. S., Concord, N. H.

Answers.—(A) Referring to Fig. 1, two cylinders (H) of hard wood may

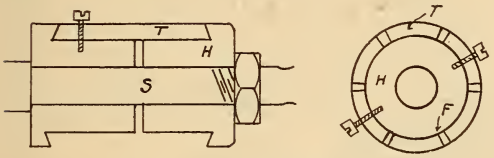


FIG. 1. CONDENSER.

be bored and turned as shown. The ring (T) of which commutator is made may be placed on the cylinder, made in halves so this can be done. The whole is driven on a lathe mandrel (S) and the

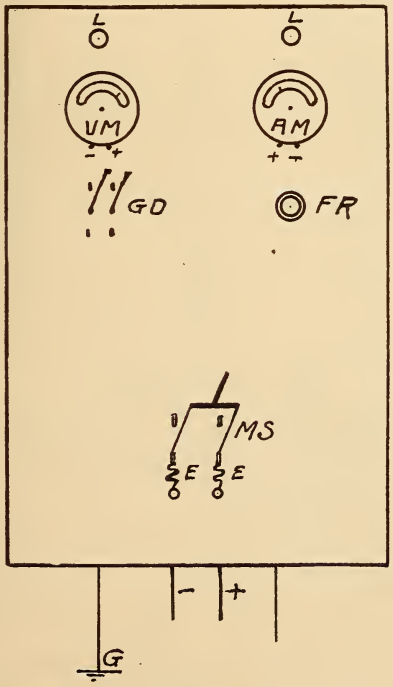


FIG. 2. D. C. SWITCHBOARD—FRONT.

nut shown, tightened. After turning and making the segments by sawing, the cuts (F) should be filled by strip mica or hard wood strips.

(B) Figs. 2 and 3 show front and back view of a switchboard in which (E, E) are fuses on leads from the generator, (G D) is a voltmeter ground detector equipped with single-pole double-thrown knife switches, (G) is ground for same. Voltmeter connections are shown with fuses (which should not be over six amperes) protecting the voltmeter

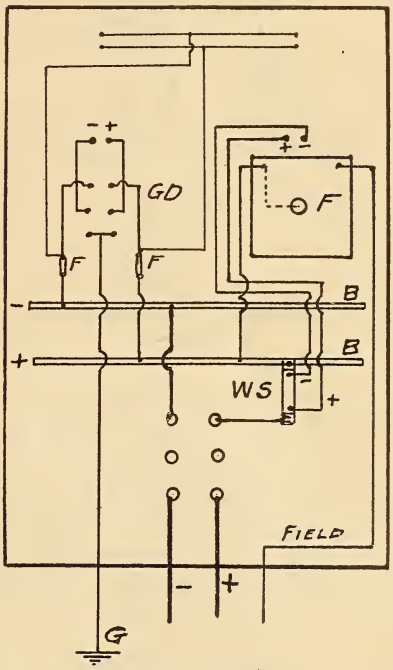


FIG. 3. D. C. SWITCHBOARD—BACK.

and two pilot lights (L, L). The ammeter is connected to a Weston shunt (W S). The shunt field rheostat (F) is shown as connected from the positive bus (B), and through this the field current is controlled. The other end of the field wire after passing around the cores is connected to the negative brush at the machine.

(C) Fig. 4 shows connections (D, D) for lightning arresters. These points should be chosen near the place where the wires enter the station. The choke coils (C, C), owing to the supposed high frequency of the lightning discharge and the self-inductance of the coils, choke back the discharge, the same passing preferably down through the arresters to ground. The arresters should be located away from the board. Not less than No. 6, B. and S. gauge copper wire

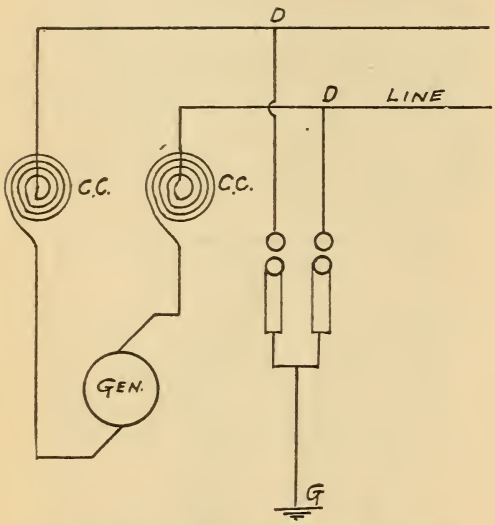


FIG. 4. LIGHTNING ARRESTER CONNECTIONS.

should be used, runs being free from kinks, coils, and sharp turns. The ground wire from the arresters should not be run in pipe. The ground plate should be fairly heavy sheet copper plate having at least four square feet of surface, buried in damp soil or soil kept so artificially. The ground wire should be riveted and soldered to the ground plate.

Magneto Generator.

Questions.—(A) Could I make a battery motor out of a telephone generator? (B) If I made a dynamo out of a telephone generator by putting a commutator on it, would I have to rewind the armature?—C. E. P., Smithshire, Ill.

Answers.—(A) Magneto generators ordinarily give from 60 to 75 volts. To run one at the high speed usual as a motor would require too many cells. A commutator would be necessary and the armature would have to be rewound for low voltage, six or eight volts. The permanent magnets also vary in flux produced. In a given generator, therefore, turning at a certain speed, the voltage will depend upon the number of turns of wire in the armature. Find by experiment how many turns of wire on the armature will give six or eight volts on an open circuit, then use the largest wire which this number of turns will allow.

(B) Not if you want 60 or 75 volts and a small current.

A 125-Cycle Motor on 60 Cycles; Winding Armature.

Questions.—(A) In the December, 1908, issue of Popular Electricity I read how to change a motor running on 125 cycles so it would run on 60 cycles. I used 150 feet of No. 23 wire on each pole piece. The fan operates, but at slow speed, and also vibrates with a humming noise. (B) How would you wind a drum armature having 36 slots?—W. W., Chicago, Ill.

Answers.—(A) The latter part of the answer to J. E. D. in issue referred to answers part of your question. The humming is due to parts of the motor being "in tune" with the frequency or alternations.

(B) Wind as follows:

Coil No.	Starts in Slot No.	Ends in Slot No.
1	1	18
2	19	36
3	7	24
4	25	6
5	31	12
6	13	30
7	3	20
8	21	2
9	27	8
10	9	26
11	33	14
12	15	32
13	23	4
14	5	22
15	11	28
16	29	10
17	35	16
18	17	34

Arc Lamp Resistance.

Questions.—(A) What size of German silver wire and how much of it will be needed for resistance in an arc lamp using ⅜-inch by 12-inch carbons? (B) For a flaming arc?—T. W. P., Chicago, Ill.

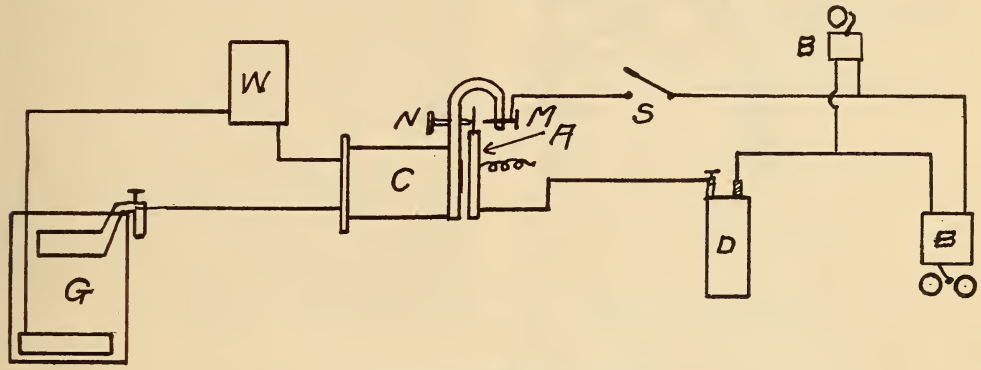
Answers.—(A) A constant potential direct current enclosed arc lamp requires about 80 volts at the arc and four amperes on a ⅜-inch carbon. A resistance of eight ohms, or one and one-third pounds of No. 14 German silver will give the necessary resistance for 12-inch carbons.

(B) A constant potential direct current flaming arc lamp is adjusted for 45 volts at the arc and a consumption of 10 to 12 amperes. A proportional decrease in resistance as noted in (A) is required.

Burglar Alarm Circuit.

Questions.—(A) Kindly explain how I may arrange a burglar alarm so as to have one large outside bell, one small inside bell and a switchboard for the equipment. (B) What are considered an electrician's helper's tools? H. G. B., Jersey City, N. J.

Answers.—(A) The diagram shows connections for a closed circuit alarm, windows (W), relay (C), and gravity battery (G). Armature (A) is normally held in contact with point (N). If circuit (W G C) is broken, relay (C) releases (A) and the spring causes contact to be made at (M) which is insulated from (N). If switch (S) is closed bells (B) ring until circuit (W G C) is closed or (S) opened. (S) and (C) could be placed on a neat wooden board and the position of (A) would indicate the condition of window circuits.



BURGLAR ALARM CIRCUIT.

(B) We do not know that any certain tools are so designated, but other things being equal the electrician's helper would be most efficient if he has the following: One rule, 2 foot; one clawhammer, No. 13; one blow lamp; one B. and S. pocket wrench, No. 4; one screw-driver bit; one set (2) Champion screw-drivers; one large screw-driver, 12 inch; one ratchet brace, No. 33; bits, ¼, ⅜, ½, ⅝, ¾, ⅞, 1 inch; one Clarke expansive bit, ⅞ to 3-inch; one gimlet bit; one wood countersink; one extension drill; ⅜ inch, length 24 inches; one long or extension gimlet; one cold chisel, ¾ inch; one wood chisel; one brick drill; one pair line pliers, 8 inch; one splicing clamp; one soldering copper, No. 3; one plumb bob; one hack saw, 10 inch; one saw, 20 inch.

Magnet Coil Winding.

Question.—Please tell me how to make a magnet coil that I may connect across 110 volts, the coil to be only one inch long. C. M., Richmond, Ind.

Answer.—Wind a bundle of iron wires with two layers of oiled paper. Upon this wind 1,000 feet of No. 30 silk-covered wire. The current through the coil when across a 110-volt circuit will be about one ampere.

A Closed Circuit Cell.

Question.—How can I make a wet, closed circuit cell other than a bichromate cell? J. A., Council Bluffs, Ia.

Answer.—The Gordon cell is made as follows: Provide a glass on porcelain jar six inches in diameter and eight inches high, with a tin or fiber tight fitting cover. In this jar suspend by an iron rod, insulated through the cover, a tin cylinder pierced full of small holes. Fasten to the outside of this cylinder down near the bottom three porcelain supports to hold and insulate a ring of zinc. To this zinc fasten a rubber covered wire and bring this wire up through cover. Brass connectors may be fastened to the upper ends of the iron rod and rubber covered wire. These are the battery terminals. Fill the jar with six pints of water and slowly add 1½ pounds of caustic soda. Now immerse the cylinder containing 2¾ pounds of oxide and around which is the zinc ring. Pour a little parrafine oil on the surface and securely fasten the cover in place. This cell gives a steady current of two amperes at seven-tenths volts or five amperes at five-tenths volts. Copper oxide, zinc, and caustic soda are required to renew the cell.

Telegraph Key and Relay.

Questions.—(A) How can I make a telegraph key? (B) How can I make a relay of high resistance?—J. L. B., Elizabeth Port, N. J.

Answers.—(A) Fig. 1 shows the working parts of a telegraph key. The circuit through the key may be traced

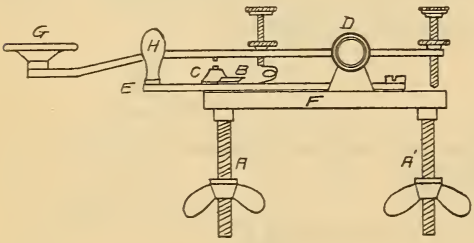


FIG. 1. WORKING PARTS OF A TELEGRAPH KEY.

from leg (A) to anvil (C) which is insulated by a hard rubber bushing and plate from base (F). With the key pressed down the current passes to trunnion (D), to base (F), and to leg (A'). (E) is a circuit closer by which the frame (F) through a metal strip (B) closes circuit through the anvil (C) and leg (A) when key is not in use. Connections are made to legs (A) and (A').

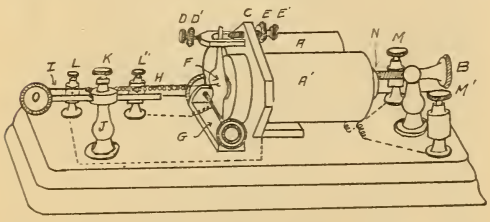


FIG. 2. TELEGRAPH RELAY.

The contact points are platinum, and (G) and (H) are of hard rubber. The rest of the instrument is of brass.

In Fig. 2 of a telegraph relay (A A') are the coils surrounding two soft iron cores, connected by a yoke (N) at one end, and adjusted by set screw (B), (A A') being adjustable through frame (C). The soft iron armature (F) operates on a trunnion held in place by a brass base (G). (D D') and (E E') are adjustment screws with lock nuts, (D D') being tipped with hard rubber. A sliding rod through (J) held in place by a set screw (K) controls the tension of the spring (H) when (O) is adjusted. Parts except as noted are of brass, the whole being mounted on a wooden base. Connecting wires are run in grooves in this base. Binding posts (M M') are connected to the line. (L L') are connected to a local battery and sounder, the circuit of which is closed by the armature. The coils (A A') are usually enclosed in hard rubber cylinders. Regarding the building of the coils, divide between two spools 2,900 feet of No. 30 B. and S. gauge wire. Place in each coil a soft iron core connected at one end by a yoke. Join the coils together so that if stretched in a straight line along the yoke forming a bar magnet, the wire will be wound in the same direction throughout. Together these coils will have a resistance of 300 ohms approximately.

Arc Lamp Rheostat.

Questions.—(A) I have a rheostat on an arc lamp taking about 45 amperes. The wire in the rheostat is German silver, No. 10 B and S gauge. The coils are exposed and after some twenty minutes' run the coils get red hot, causing a breakdown about once a month. Could I inclose this rheostat in an oil proof air tight box filled with crude petroleum to prevent heating and breakdown?

(B) Would the oil serve to cut my resistance down?

(C) Would there be any danger of fire?

(D) Will you give a diagram of a transformer stepping 110 volts down to 55 volts and capable of delivering 40 to 60 amperes?—W. A. McD., St. Louis, Mo.

Answers.—(A) No. 10 German silver wire (18 per cent nickel) has a carrying capacity of 8½ amperes. Increase the size of the wire and in the same proportion increase the length. This will keep the resistance the same as now, but increase the carrying capacity. It is not advisable to cool the rheostat with petroleum.

(B) No.

(C) The Fire Underwriters' laboratories do not approve the oil cooled rheostat because they believe it increases the fire hazard.

(D) The specifications for the design of a transformer such as you suggest hardly come within the scope of this department.

Effect of Lines of Force.

Question.—I have a galvanometer made of a coil of wire, inside of which is a pocket compass. When I connect this galvanometer across the primary of an induction coil having a make-and-break contact the needle will gradually commence to revolve. What is the cause? M. B. G., New York City.

Answer.—When a current is passed through a coil of wire, magnetic lines of force are built up inside the coil. Any magnetic metal inside this coil will try to place itself in the path of these lines longitudinally. In the case you describe the magnetic lines are made and then die out because the interrupter on the coil makes and breaks the circuit. When the circuit is made the needle seeks to place itself along the path of the lines, which lines immediately disappear, leaving the needle to swing on around until the next pull is impressed upon it. The speed is regulated by the speed of the make and break.

Winding Small Drum Armature.

Questions.—(A) Armature, 2⅛ inches in diameter and 2⅞ inches long. How much and what size wire should I use to get 50 volts, armature to be drum wound? (B) Does a six-segment commutator require 12 slots in the armature?—A. Curtis, Cleveland, Ohio.

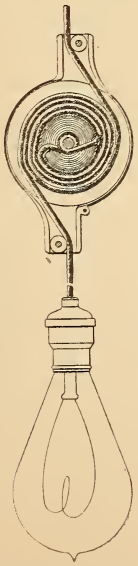
Answers.—(A) With field coils in shunt, provide 12 slots and 12 segments, the slots being ¼ inch wide by ¼ inch deep. Use 14 ounces of No. 22 wire on armature and 2¾ pounds of No. 24 wire on the field coils.

(B) There may be six, 12, 18, or so on, slots (some multiple of six) in the armature.

NEW ELECTRICAL INVENTIONS.

ELECTRIC LIGHT FIXTURE.

A device for raising and lowering electric incandescent lamps has been patented by William Amstalden of Amador City, Cal. As shown in the cut it contains a drum which winds up and unwinds the cord. The drum is provided with a spring and ratchet arrangement, similar to that of a curtain roller, which permits of the lamp being adjusted at any desired height.



ELECTRIC LIGHT FIXTURE.

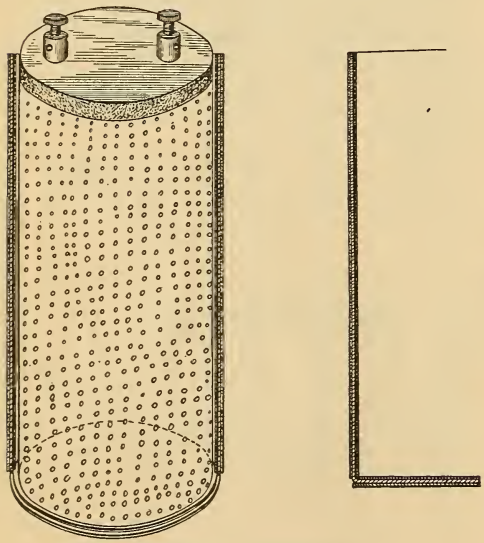
RENEWING DRY CELLS.

It is well known that dry batteries commence to deteriorate from the time they are made and that therefore it is always a matter of uncertainty in purchasing a cell whether it will continue to be efficient for several months or only for a few days. At the present time, as soon as the voltage of such a cell falls below a certain amount, the cell must be discarded and a new one bought. The purpose of an invention made by H. B. Ramey of Alexandria, Va., is to enable such a cell to be revivified with very little trouble and slight expense so that its period of usefulness will be extended for a length of time at least equal to that for which it could be used if put in service immediately after its manufacture.

The invention consists, broadly speaking in applying to the exterior of the cell a casing carrying a dry electrolyte which, upon the application of moisture, sets up a chemical action with the exterior zinc surface of the cell and, the

latter being perforated, causes electrical action to be again produced.

The casing or cup consists of an external waterproof casing and an internal absorbent lining. A sheet of the absorbent paper of the proper size, to form a cylinder of the desired diameter, is impregnated with a solution containing ten parts of muriate of ammonia, four parts of bichromate of potash and ten parts of



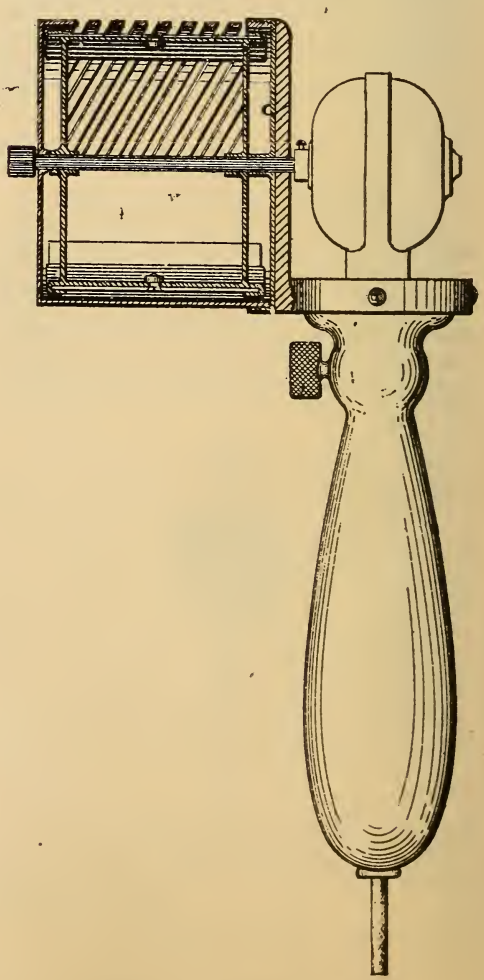
RENEWING DRY CELLS.

chloride of sodium. This sheet is then dried, preferably by passing it between rollers which serve to incorporate the chemicals firmly and to extrude the excess of water, and is wrapped around a wooden cylinder of appropriate diameter. It is then coated externally with a waterproofing paste. Around this is then wrapped a coating of Manila paper, the end of the cup being formed by placing a disk of similar paper at the end of the cylinder in the inside and folding the sheet of Manila paper over it.

The usual external casing of paper is next removed from the cell and the zinc surface cleaned. After wiping off the surface the zinc is perforated in a number of places with a small sharp instrument and the coal tar in the top of the cell is removed by tapping around the edge with a hammer. The cell is then placed within the prepared cup and the top is filled with clean water, preferably rain water. Chemical action will then immediately be produced between the outer surface of the zinc and the electrolyte contained in the porus lining of the cup and the terminals of the cell will show practically the same voltage as it did when it was new. By replenishing the water from time to time, say once a month for example, the life of the cell can be prolonged for a considerable time.

ELECTRIC SAFETY RAZOR.

The latest application of electricity to be suggested is an electric safety razor, and Luigi Brunacci of New York, N. Y., has secured a patent on the idea. The device, as shown in the cut, consists



ELECTRIC SAFETY RAZOR.

of a handle, on the end of which is mounted a very small electric motor whose shaft projects through a barrel-like casing. On the shaft inside the casing are mounted revolving arms which carry two razor blades, the keen edges of which just skim the interior surface of the casing. Diagonal slots are cut through the casing and as the latter is passed over the face the hairs protrude through the slots and are cut off by the blades.

BOOK REVIEWS.

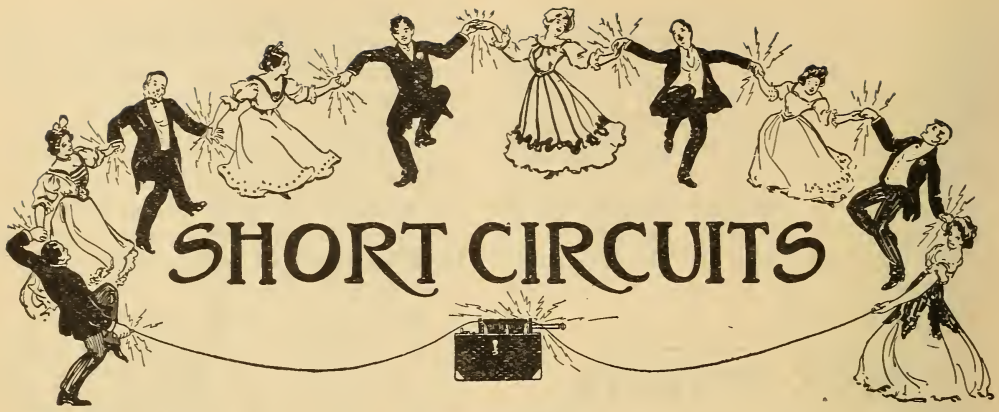
HARPER'S HOW TO UNDERSTAND ELECTRICAL WORK. By William H. Onken, Jr., and Joseph B. Baker. New York: Harper & Brothers, 1908. 359 pages, with 171 illustrations. Price, $1.75.

Far off in the distant West the sun beats down on the snowcapped mountains. Rivulets of water flow down the sides, joining others on their way, until at last the swelling tide is met by a wall of steel and concrete. Fighting against this man-made barrier, the water at last finds a small opening leading to a canal which winds its way along the mountainside. Suddenly it comes to a precipitous height and plunges down through steel tubes to the power house far below. Emerging from its narrow prison the maddened water seeks to escape, and in its outward rush it brushes aside the blades of the massive water turbine attached to an electric generator. A switch is thrown and the next instant a million lights spring into being in cities over 200 miles away. Along the route of the transmission lines hamlets, villages, towns and cities feel the pulse of this resistless energy. Let that pulse stop beating and all progress is stopped.

How to understand this new and wonderful force—electricity—is a problem which is now occupying the minds of people in the ordinary walks of life. A few decades ago it was only the most venturesome engineers who were seriously studying the subject; a few generations ago only some dozens of pioneers in science contemplated it seriously. Of all the theoretical and experimental work that has been done in these years and which will be done in the future, little will be understood by the layman. But to become conversant with the practical things which are now being done electrically is the desire of every intelligent person who wishes to keep abreast of the times in the age in which he is living.

There is very little of the theoretical in this book, but it answers so many of the practical questions in electricity so clearly and concisely that to the non-technical public it will be found both interesting and instructive. For instance, it tells you how electricity is made. It is easy to push a button and get a light, but the reason and the source of this power is to most people a mystery. Then in the same simple way the application of this power to lighting, heating, transportation, farming, mining, etc., is explained.

ILLUMINATION.—Another field of business endeavor has been invaded by a trade paper, and, with the appearance of the initial number of Illumination, which is just now being circulated, a new publication that will cater to the interests of those engaged in the field of lighting and fixtures is launched. The initial number presents a very striking appearance, and the sub-title gives an additional clew to the nature of the publication—"A Magazine of Light." In the first number, Mr. E. G. Cowdery, manager of the People's Gas Light and Coke Company, writes his ideas of "Gas as an Illuminant." Emily Calvin Blake, a well-known magazine writer, begins a series of articles dealing with the early history of the various means of lighting. Waldon Fawcett tells for the first time the story of the use and development of the new illuminant, "Lusol," which is being extensively experimented with by the French government. Lem F. Parton, who has just returned from an extended tour throughout all of South America, takes up this interesting portion of the western hemisphere and shows where there are great possibilities for the location of power and lighting plants. In the make-up the magazine presents a very unique and high-class appearance. It is well edited and well printed, and if appearance counts it should prove to be a winner. H. B. Shontz is manager and Wesley A. Stanger is editor. The home office of the magazine is in the Monon Building, Chicago.



Willie Vet—"What's an army endurance test, ma?"

Mother Vet—"Living with your pa the first few days after he gets his pension money."

* * *

I shot an arrow in the air, it went in the distance, I know not where, till a neighbor said that it killed his calf, and I had to pay him six and a half ($6.50). I bought some poison to slay some rats, and a neighbor swore it killed his cats; and rather than argue across the fence, I paid him four dollars and fifty cents ($4.50). One night I set sailing a toy balloon, and hoped it would soar till it reached the moon; but the candle fell out on a farmer's straw, and he said I must settle or go to law. And that is the way with the random shot; it never hits the proper spot; and the joke you spring that you think so smart, may leave a wound in some fellow's heart.

* * *

Never having taken a sea trip, Mr. Cobb one day conceived the idea of making a voyage to New York. Accordingly he sailed from Boston in a small schooner.

The first day out a storm was encountered and Mr. Cobb became violently sick, but after several hours he mustered up courage and strength to look out upon the troubled waters.

As he looked from the side of the little ship up the trough of the sea, it seemed very smooth to him. The captain's cutting of the waves was "senseless," he told himself.

But as this mad steering continued, the unhappy passenger finally crawled out, on hands and knees, to where the captain stood at the wheel, and raising his voice above the din of waves and wind, shouted:

"Man, man, keep in the ruts, keep in the ruts!"

* * *

A young theologian named Fiddle
Refused to accept his degree.
"For," said he, " 'tis enough to be Fiddle
Without being Fiddle D.D."

* * *

"Oh, I couldn't love him!"

"Why not?"

"He wears a wig!"

"The very idea!"

Then the dear creature removed two rats, some puffs, a coronet braid, a pompadour and a switch, and sat down to peruse a novel.

* * *

Mother (indignantly)—"You naughty boy! Stop pulling that poor cat's tail."

Little Innocent—"I'm not pulling it. I'm only holding on. The cat is doing the pulling herself."

* * *

"Well, good-bye, dear!" said Mr. Trueboy to his beloved spouse. "I must go and dictate those letters—twenty-six of them—so you mustn't expect me home very early."

"All right," was the response. "But I wish you wouldn't work so hard."

Half an hour later Mr. Trueboy entered his club and sat down, with three others, at a card table.

"Just a moment, you fellows, before the first hand is dealt. I've got to keep my word with my wife. One of you just take down what I dictate: 'A b c d e f g h i j k l m n o p q r s t u v w x y z.' There! Those letters are off my mind!"

* * *

A recent church notice in Manchester, England, read: "A potato pie supper will be held on Saturday evening. Subject for Sunday evening. 'A Night of Agony.' "

* * *

"I had to sell my auto, but I haven't missed it yet."

"How's that?"

"You can get most of the sensation by cleaning rugs."

* * *

Old Mr. Flaherty was a general favorite in the little town where he lived. The doctor was away during the early part of the summer and did not hear of the old man's death. Soon after his return he met Miss Flaherty and inquired about the family, ending with:

"And how is your father standing the heat?"

* * *

Johnny's mother gave him two five-cent pieces—one for candy, the other for the Sunday-school collection.

Light-hearted, he was tossing the coins in the air on his way to the church, when suddenly one eluded his grasp and disappeared through a cellar grating. Down on his knees he peered into the dark pit, only to realize his loss. Then looking thoughtfully, first into his hand, next at the cellar steps, he remarked: "Well, there goes the Lord's nickel!"

* * *

"Why are you so sad?" an acquaintance asked a young man whose aunt had just died. "You never appeared to care much for the poor lady." "I didn't," said the youth dolefully; "but I was the means of keeping her in a lunatic asylum during the last five years of her life. She has left me all her money, and now I've got to prove that she was of sound mind!"

* * *

Breathes there a man with soul so dead who, when outdoors he pokes his head on days like these, says not, "I wish I had the time to take a fish?"—Washington Herald.

Oh, yes; I know a chap who is so blooming lazy that, gee whiz, he has no fond desire to roam, but drinks the "bait" and stays at home. —Houston Post.

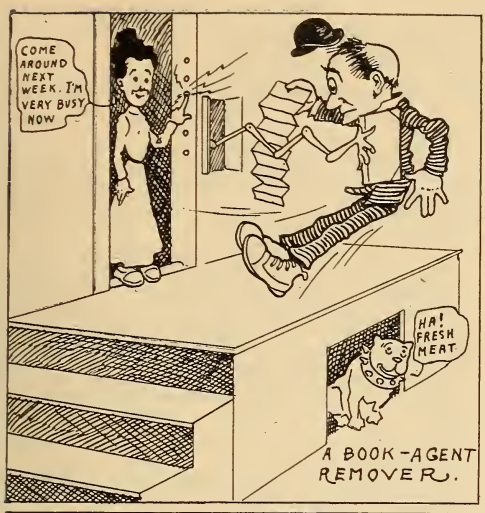
* * *

Alpine Hotel Manager (to the man who has the telescope for hire)—"The Kaiser is coming here to-morrow. Be careful to say nothing to him about the majesty of the mountains."

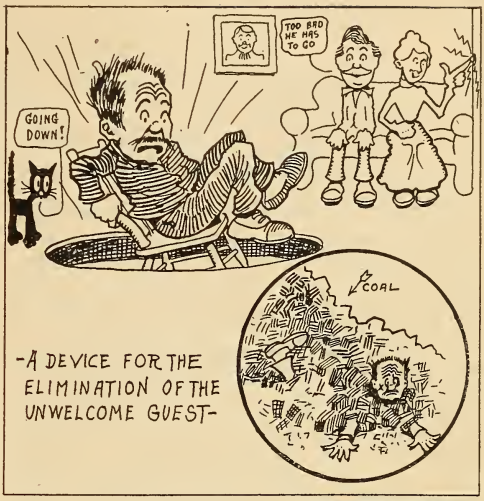
* * *

A sign hung in a conspicuous place in a store in Lawrence reads:

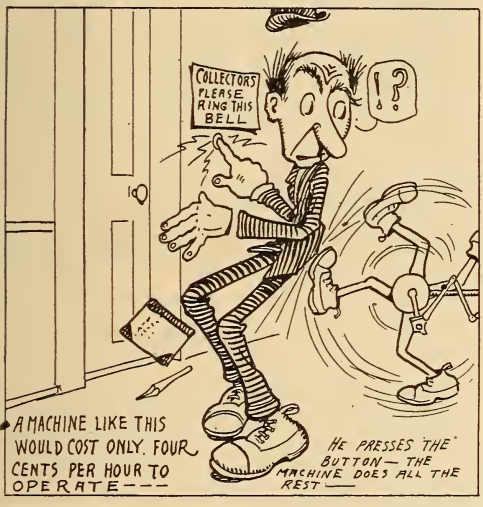
"Man is made of dust. Dust settles. Are you a man?"



A BOOK-AGENT REMOVER.

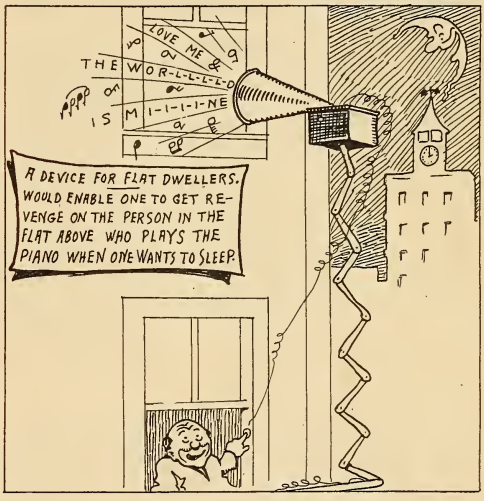


-A DEVICE FOR THE ELIMINATION OF THE UNWELCOME GUEST-

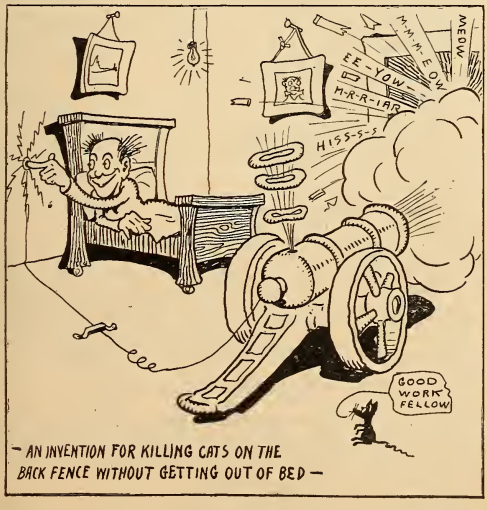


A MACHINE LIKE THIS WOULD COST ONLY FOUR CENTS PER HOUR TO OPERATE---

HE PRESSES THE BUTTON— THE MACHINE DOES ALL THE REST

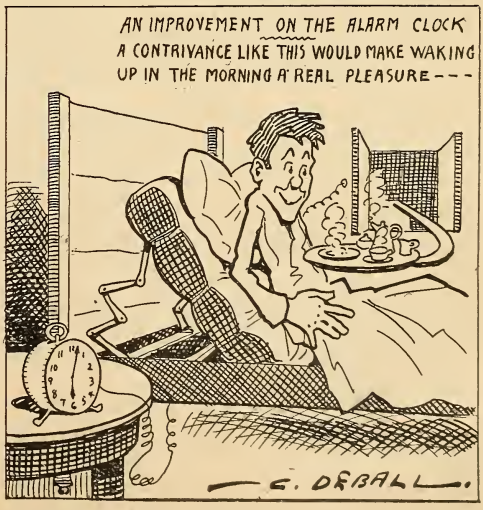


A DEVICE FOR FLAT DWELLERS. WOULD ENABLE ONE TO GET REVENGE ON THE PERSON IN THE FLAT ABOVE WHO PLAYS THE PIANO WHEN ONE WANTS TO SLEEP.



— AN INVENTION FOR KILLING CATS ON THE BACK FENCE WITHOUT GETTING OUT OF BED —

AN IMPROVEMENT ON THE ALARM CLOCK
A CONTRIVANCE LIKE THIS WOULD MAKE WAKING UP IN THE MORNING A REAL PLEASURE---



— C. DEBALL —

HELPFUL HINTS FOR ELECTRICAL INVENTORS.

ELECTRICAL DEFINITIONS.

Accumulator.—Storage battery.

Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.

Ammeter.—An instrument for measuring electric current.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt.

Ampere Hour.—Quantity of electricity passed by a current of one ampere flowing for one hour.

Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.

Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.

Branch Conductor.—A parallel or shunt conductor.

Brush.—The collector on a dynamo or motor which slides over the commutator or collector rings.

Bus Bars.—The heavy copper bars to which dynamo leads are connected and to which the out-going lines, measuring instruments, etc., are connected.

Buzzer.—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.

Candle Power.—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.

Capacity, Electric.—Relative ability of a conductor or system to retain an electric charge.

Charge.—The quantity of electricity present on the surface of a body or conductor.

Choking Coil.—Coil of high self-inductance.

Circuit.—Conducting path for electric current.

Circuit-breaker.—Apparatus for automatically opening a circuit.

Collector Rings.—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.

Commutator.—A device for changing the direction of electric currents.

Condenser.—Apparatus for storing up electrostatic charges.

Cut-out.—Appliance for removing any apparatus from a circuit.

Cycle.—Full period of alternation of an alternating current circuit.

Diamagnetic.—Having a magnetic permeability inferior to that of air.

Dielectric.—A non-conductor.

Dimmer.—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.

Direct Current.—Current flowing continuously in one direction.

Dry Battery.—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.

Electrode.—Terminal of an open electric circuit.

Electromotive Force.—Potential difference causing current to flow.

Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.

Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.

Electroscope.—Instrument for detecting the presence of an electric charge.

Farad.—Unit of electric capacity.

Feeder.—A copper lead from a central station to some center of distribution.

Field of Force.—The space in the neighborhood of an attracting or repelling mass or system.

Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.

Galvanometer.—Instrument for measuring current strength.

Generator.—A dynamo.

Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.

Insulator.—Any substance impervious to the passage of electricity.

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

Leyden Jar.—Form of static condenser which will store up static electricity.

Lightning Arrester.—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.

Motor-dynamo.—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.

Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.

Multiple Circuits.—See parallel circuits.

Neutral Wire.—Central wire in a three-wire distribution system.

Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in height.

Parallel Circuits.—Two or more conductors starting at a common point and ending at another common point.

Polarization.—The depriving of a voltaic cell of its proper electromotive force.

Potential.—Voltage.

Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.

Rheostat.—Resistance device for regulating the strength of current.

Rotary Converter. — Machine for changing high-potential current to low potential or vice versa.

Secondary Battery.—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.

Self-inductance.—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.

Series.—Arranged in succession, as opposed to parallel or multiple arrangement.

Series Motor.—Motor whose field windings are in series with the armature.

Shunt.—A by-path in a circuit which is in parallel with the main circuit.

Shunt Motor.—Motor whose field windings are in parallel or shunt with the armature.

Solenoid.—An electrical conductor wound in a spiral and forming a tube.

Spark-gap.—Space between the two electrodes of an electric resonator.

Storage Battery.—See secondary battery.

Thermostat.—Instrument which, when heated, closes an electric circuit.

Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

Volt.—Unit of electromotive force or potential. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

Voltage.—Potential difference or electromotive force.

Volt Meter.—Instrument for measuring voltage.

Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.

Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.

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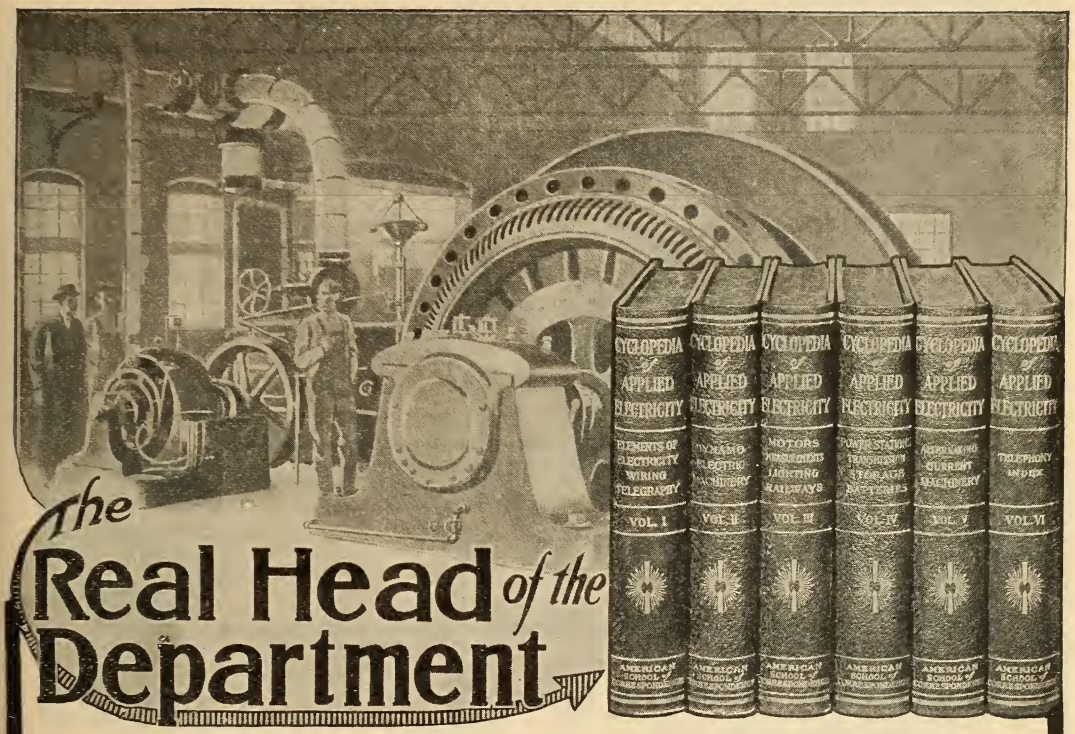

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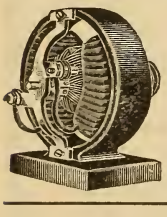

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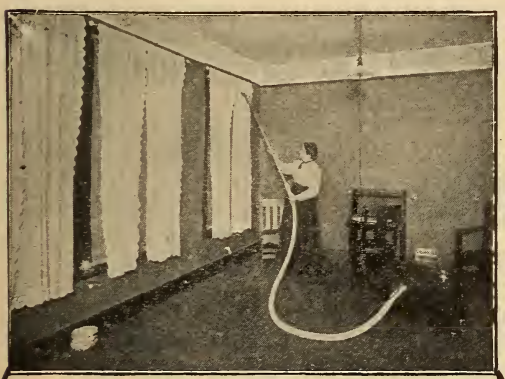

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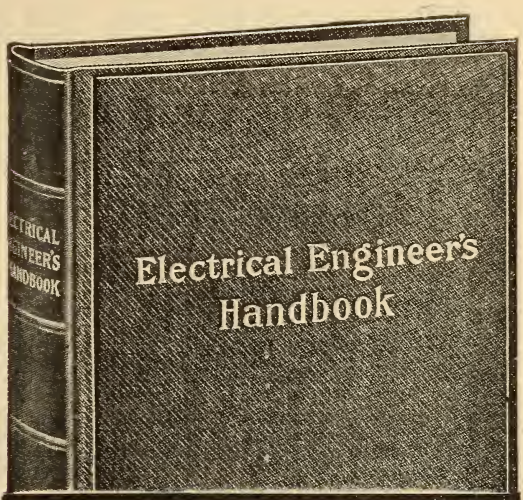

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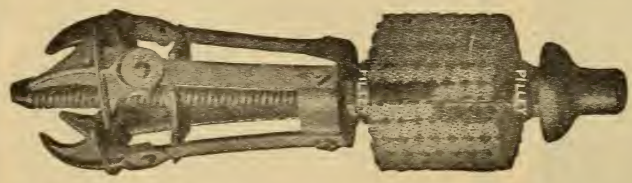

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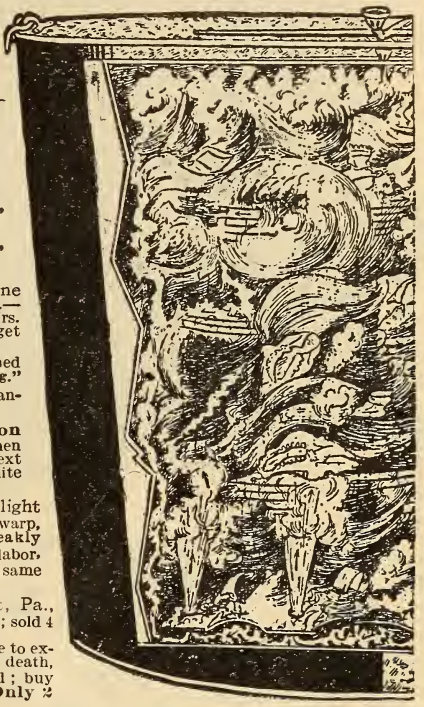

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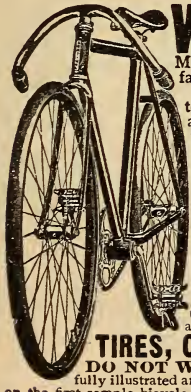

WANTED--A RIDER AGENT IN EACH TOWN

and district to ride and exhibit a 1909 Model **"Ranger"** bicycle furnished by us. Our agents everywhere are making money fast. *Write for full particulars and special offer at once.*

NO MONEY REQUIRED until you receive and approve of your bicycle. We ship to anyone, anywhere in the U. S. *without a cent deposit* in advance, *prepay freight,* and allow **TEN DAYS' FREE TRIAL** during which time you may ride the bicycle and put it to any test you wish. If you are then not perfectly satisfied or do not wish to keep the bicycle you may ship it back to us at our expense and *you will not be out one cent.*

FACTORY PRICES We furnish the highest grade bicycles it is possible to make at one small profit above actual factory cost. You save $10 to $25 middlemen's profits by buying direct of us and have the manufacturer's guarantee behind your bicycle. **DO NOT BUY** a bicycle or a pair of tires from *anyone* at *any price* until you receive our catalogues and learn our unheard of *factory prices* and *remarkable special offers* to **rider agents.**

YOU WILL BE ASTONISHED when you receive our beautiful catalogue and study our superb models at the *wonderfully low prices* we can make for 1909. We sell the highest grade bicycles for less money than any other factory. We are satisfied with $1.00 profit above factory cost. **BICYCLE DEALERS,** you can sell our bicycles under your own name plate at double our prices. Orders filled the day received.

SECOND HAND BICYCLES. We do not regularly handle second hand bicycles, but usually have a number on hand taken in trade by our Chicago retail stores. These we clear out promptly at prices ranging from $3 to $8 or $10. Descriptive bargain lists mailed free.

TIRES, COASTER-BRAKES, single wheels, imported roller chains and pedals, parts, repairs and equipment of all kinds at *half the usual retail prices.*

DO NOT WAIT, but write today and we will send you **free** by return mail our **large catalogue,** beautifully illustrated and containing a great fund of interesting matter and useful information; also a *wonderful proposition* on the first sample bicycle going to your town. It only costs a postal to get everything. **Write it now.**

MEAD CYCLE COMPANY Dept. P 251 CHICAGO, ILL.

If you want a good piano **we save you from $100 to $300** by our direct factory-to-purchaser system.

WING PIANOS

are ***made by us,*** in our own factory. They are ***sold direct from our factory*** and ***in no other way.*** Every unnecessary cost is eliminated. Every dollar spent with us is piano value through and through—the best that 40 years of study and experience can produce. The ***lowest, factory-price*** consistent with an artistically and musically perfect instrument.

THE WING TONE is so sweet and deep it is in a class of its own. Thousands of customers yearly write and tell us so. "Pure and sweet; every note clear and musical; responsive to the lightest touch, yet possessing great volume and power, without a trace of harshness"—this describes the tone of the WING PIANO.

THE WING WAY

We will place a WING PIANO in any home in the United States on trial entirely at our expense, without any advance payment or deposit. If, after 20 days' trial in your own home, it is not satisfactory, we take it back. ***Nothing to be paid by you before it is sent, when it is received, or when it is returned.*** **You are under no more obligation to keep the piano than if you were examining it at our factory. Every expense and all risk is *ours*, absolutely.** ***Easy installment payments, if you desire them.***

When you buy a piano at retail you pay the retail dealer's store rent and other expenses; you pay his profit and you pay the commission or salary of the agents or salesmen he employs. **We make the WING PIANO** and sell it ourselves. **We employ no agents or salesmen.** When you buy the WING PIANO you pay the actual cost of construction plus **only** our small wholesale profit. This profit is small because we sell thousands of pianos yearly. Most retail stores sell no more than 12 to 20 pianos yearly and must charge from $100 to $300 profit on each. You can calculate this yourself. These dealers get as much profit on their cheap pianos as on the standard high grade ones. As the cheap pianos cost less than half, they "talk up" and push the cheap pianos—but often call them high grade.

Pioneers of the direct plan of piano selling, our unparalleled success has brought forth **many imitators,** but **no competitors,** either as to the excellence of our product or the integrity and economy of our methods. Forty years of daily increasing business and 45,000 satisfied and enthusiastic buyers testify to this.

Ask a Wing customer what he thinks of Wing Pianos and Wing methods. We will send you names in your locality for the asking.

Our commercial standing and references will guarantee you that our word is good and contract gilt-edged. The publishers of any prominent magazine will also tell you this.

The WING PIANO is broadly guaranteed in writing for 12 years.

FREE EVEN IF YOU ARE NOT READY TO BUY WRITE OR SEND THE COUPON TO-DAY

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370-391 W. 13th St., New York

Send to the name and address written below, your **Free Books** without any cost or obligation on my part.

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"The Book of Complete Information About Pianos."

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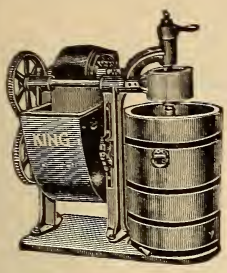
If you choose, **and without extra cost,** your piano can have this wonderful addition, Imitates **perfectly** the mandolin, guitar, harp, zither, and banjo. Music written for these instruments, can be played just as perfectly by a single player on the piano as though rendered by an orchestra. It is an intregal part of the instrument; does not take in any way from its tone or value as a piano and prolongs the life of the strings and action.



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A complete ice cream plant in one machine —electrically driven. No belts or pulleys. Requires small space. Why not make your own ice cream and save money? The ideal freezer for confectioners and druggists. Made in 2 sizes—20 and 40 quart. Write for catalogue and prices.

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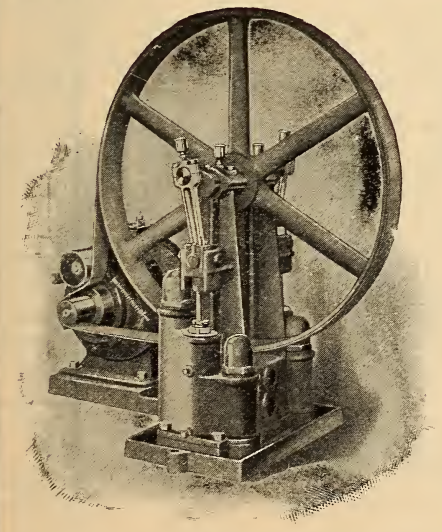
TELEPHONES SPREADING CONSUMPTION

Have you ever estimated YOUR chances of escape from the deadly clutches of
THE GREAT WHITE PLAGUE!!!

They are easily estimated and you would find them alarmingly small. Consumption killed 1,500,000 persons during 1908, 200,000 of whom died in the United States. One-third of all deaths between the ages of 20 and 45 are caused by consumption; according to these official estimates over six million persons now living in the United States will die of consumption. This makes your chance of escape less than 1 to 15 and the subject of prevention should be of interest.

Consumption is a communicable germ disease largely spread by the sputum of those affected, which dries, mingles with dust and floats around in the air we breathe. It is bad enough for a consumptive to expectorate on the street but absolutely criminal for him to use an undisinfected phone. In the open the winds scatter the dust and germs, the sun kills many of them, but when a consumptive uses an undisinfected phone scores of small particles of sputum carrying thousands of germs of consumption are projected right into the interior of the mouthpiece in the act of speaking. They are carried into a small dark confined space measuring about one cubic inch where no friendly winds can reach to scatter them and where no sunlight can penetrate to kill them, on the contrary they are constantly warmed and moistened by the breath of those who use the phone which forms an ideal incubator where they multiply in enormous numbers, as has been repeatedly proved by scientists. The germs of consumption imprisoned in the mouthpiece of the phone have only one way of escape, through the open mouthpiece and when you place your mouth close to the phone and in conversation inhale deeply you may draw them right into your lungs by the thousand. You cannot prevent consumptives using the phone because thousands are infected for weeks and months before they or any one else recognizes their complaints as consumptive and before their disease has been diagnosed as tuberculosis, but YOU CAN remove all danger of infection through your phone by equipping it with a DIOZO Phone Disinfector at a cost of only 50 cents a year and advise your friends to do likewise. Write for free booklet on DIOZO as a factor in the prevention of disease. Parker Chemical Co., Chicago.

ELECTRICITY Will Do Your PUMPING



In Homes, Apartment Houses, Office Buildings, Suburban Residences.

The Sanitary Electric Pump will run on any 110 Volt current. Perfectly Safe, lasts a life time.

Pumps 50 gallons per minute. Operates with less power and sells for less money per gallon delivery than any other.

Write and ask us all about it.

SANITARY PUMP COMPANY
100 Canal Street, Dayton, Ohio.

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Situated adjacent to the shopping district, visitors are at all times welcome to the conveniences afforded by this permanent home for the exhibition of modern light, power and heat.

Aside from the display of lamps, unequalled in the West for artistic and exclusive designs, **Electric Shop** affords an exceptional means for information as to the manifold electrical conveniences and comforts in the home and the application of electrical power to all manner of commercial uses.

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WM. D. McJUNKIN ADVERTISING AGENCY, CHICAGO.

For our Mutual Advantage mention Popular Electricity when writing to Advertisers

Refinish a Piece of YOUR Furniture at OUR Expense

Let us send the Materials Free

WE WANT a sample of wood finishing done with our preparations in your home. We will send the materials to do the work. Here they are:

A bottle of Johnson's Electric Solvo to quickly remove the old finish—

A bottle of Johnson's Wood Dye (you to choose the color from our 14 different shades) to color the wood—

A sample of Johnson's Prepared Wax to give that beautiful "hand-rubbed" effect—

And our illustrated guide book for home beautifying which includes complete color card and tells how to finish and refinish wood.

No doubt you have some piece of furniture that you prize highly, yet do not use on account of the worn condition of its finish, or because it does not harmonize with other furniture or decorations.

Use this outfit, which we want to send you free, for refinishing it, and you will be surprised to learn how easily the work is done and the beauty of the result.

May we send you these three packages, and the valuable six-color book, free at once? Learn from the test the beautiful effect obtained from the use of

Johnson's Wood Dye

It is not a mere stain. It is a deep seated dye—sinking into the pores of the wood and bringing out the beauty of the grain. When finished with Johnson's Prepared Wax you have a permanent finish of real beauty and most artistic effect. We want to give you these three packages at once, absolutely free. You can either send us your name and address on a postal or in letter requesting them or use coupon below printed for your convenience.

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No. 140 Manilla Oak	*No. 121 Moss Green*
No. 110 Bog Oak	*No. 122 Forest Green*
No. 128 Light Mahogany	*No. 172 Flemish Oak*
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Half-pints 30c; pints 50c. Johnson's Prepared Wax 10c and 25c packages. Also sold in large sizes. For sale by all leading paint dealers. Send coupon today to

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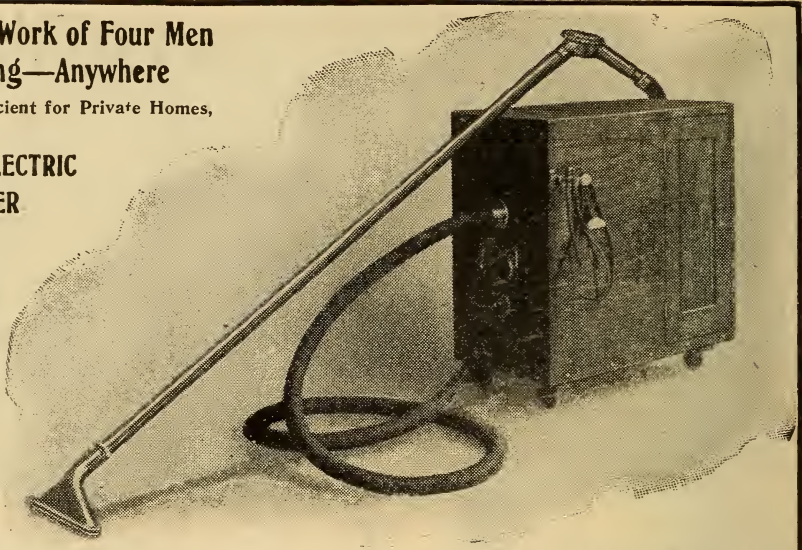

Has a range of from 0 to 12 inches vacuum. ¶It is set to operate on 8 inches at the nozzle. ¶It will thus remove all the dust and dirt from inside, under and on top of carpets, rugs, etc., without injury or wear to the finest fabrics Turkish rugs, etc. ¶It is operated from any electric light socket. Simply screw in the plug and turn on the current, same as you would a light bulb. ¶It takes only about one-quarter the current of any other machine. Costs about 2 cents per hour for electricity. ¶It is mounted on ball-bearing, roller swivel, rawhide casters, and can be wheeled from room to room. ¶It is light in weight (weighing about 100 pounds), and can readily be carried up and down stairs. ¶It is always ready for instant use. ¶It is not a toy, but a powerful complete machine, doing all the work of a $3,000 plant. ¶It has no valves to wear out and make a noise. ¶It is practically noiseless. Makes about as much noise as a sewing machine. ¶It has no expensive parts to wear out. It will last a lifetime with ordinary use and care, without repairs. ¶It is practically "fool proof." ¶It is simple and can readily be operated by any housemaid. ¶It is an ornament, finished in highly polished oak. Cabinet can be left in a room or stored away in a closet. Looks more like a silver chest than a machine. ¶A bag cannot be used on our Positive Vacuum Machine. It will pull the dirt right through a bag. ¶We guarantee that our Positive Cleaner will take up dust from any rug that has just been cleaned by any other machine.

Manufactured Only by **ELECTRIC CLEANER COMPANY** Write for Catalog at once.

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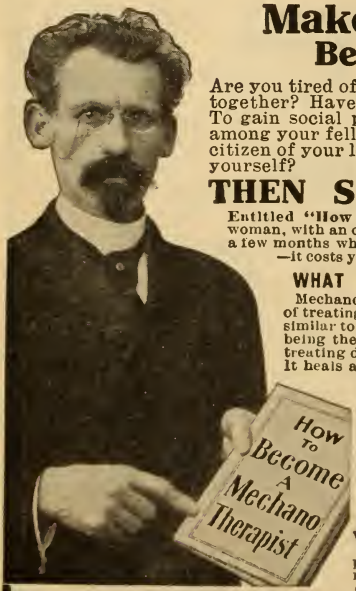

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CAN I LEARN IT?

Have you asked yourself this question? We answer unhesitatingly, YES.

If you have so much as an ordinary, common school education you can learn.

You learn if you have the ambition to better your condition.

We can teach you in a very short time, so you may enter this profession—when you do, you begin to make money. We supply all lessons and necessary text books free of cost to you. No apparatus is used. You do not even need a place to work. All you require is your two hands. Certainly you can learn. The free book tells all.

We Teach You in Your Own Home

We can teach you an honorable and profitable profession in a few months, which will insure your financial independence for life, making it possible to have an income of $3,000 to $5,000 a year. We teach you by mail, in your own home, without interfering with your present duties. No matter how old you are. Any person—man or woman—with just an ordinary school education, can learn Mechano-Therapy. It is easy to learn and results certain. We have taken hundreds of men and women who were formerly clerks—farmers—stenographers—telegraph operators—insurance agents railway employes—in fact, of nearly every known occupation—old men of 70 years who felt hopeless—young men of 20 years, without a day's business experience—salaried men, who could see nothing in the future but to become Oslerized, and laboring men, who never realized that they had within themselves the ability to better their conditions. Write for our FREE book, which explains all—today.

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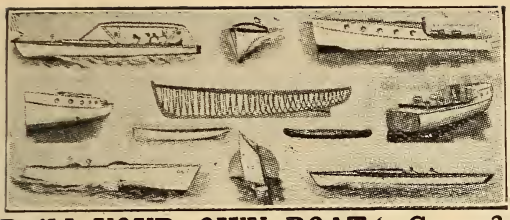

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Send for my 1909 Catalog No. 22 today

I can supply you with the framework for your boat, shaped, machined, every piece fitted and ready to put together, for less money than most lumber dealers charge for suitable rough lumber.

It shows 100 new models.

Today there are more boats built by inexperienced amateurs using my system, than by all the boat factories.

I can save you (1) the boat builder's profit; (2), labor expense; (3), big selling expense; (4), ¾ of the freight. Figure it our yourself.

YOU TAKE NO RISK

I absolutely guarantee that you will be perfectly satisfied with everything you purchase of me, or your money will be instantly refunded.

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I can save you two-thirds on high grade Mission furniture shipped knock-down, in sections, not in pieces.

Put the K. D. Sections Together Yourself

As you receive it—with cushions made ready to drop in place. Just six joints to put together.

Every piece is of selected solid oak, massive, simple, always in good taste, and of a style that never changes.

C. C. BROOKS, Pres., BROOKS MFG. CO.

4205 Ship Street, SAGINAW, MICHIGAN, U. S. A. Est. 1901.

Originators of the Knock-Down System of Boat Building and Home Furnishing.

Do You Hear Well?

The Stolz Electrophone—A New, Electrical, Scientific and Practical Invention for those who are Deaf or Partially Deaf—MAY NOW BE TESTED IN YOUR OWN HOME.

Deaf or partially deaf people may now make a month's trial of the Stolz Electrophone at home. This personal practical test serves to prove that the device satisfies *with ease*, every requirement of a perfect hearing device. Write for particulars at once, before the offer is withdrawn, for by this *personal test* plan the *final* selection of the one *completely satisfactory hearing aid* is made easy and inexpensive for every one.

This new invention, the Stolz Electrophone (U.S. Patent No 763,575) renders unecessary such clumsy, unsightly and frequently harmful devices as trumpets, horns, tubes, ear drums, fans, etc, It is a tiny electric telephone that fits on the ear and which, the instant it is applied, *magnifies* the sound waves in such manner as to cause an *astonishing increase* in the *clearness* of *all sounds*. It overcomes the buzzing and roaring ear noises and, also, so constantly and electrically exercises the vital parts of the ear that, usually, the natural unaided hearing itself is gradually restored.

Mrs. C. Lidecka, 238 12th Ave., Maywood, Ill., wears an Electrophone

Less conspicuous than eyeglasses

What Three Business Men Say:

The Electrophone is very satisfactory. Being small in size and great in hearing qualities makes it preferable to any I have tried and I believe, I have tried all of them. M. W. HOYT, Wholesale Grocer, Michigan Ave. and River St., Chicago.

The Stolz Electrophone Co., Chicago, Ill. Gentlemen:—I have used your Electrophone since July 1908. It enables me to hear speakers over 50 feet away. Without it I could not hear their voices. It has improved my natural hearing at least 50%, and has stopped the head noises which were so annoying. Refer to me at any time. Yours truly, E. P. ROGERS, Suite 908-159 LaSalle St., Chicago, Ill.

I have now used your Electrophone over a year, and know that it is a first-class, scientific hearing device. Without it people have to shout directly in my ear to make me hear. With it, I can hear distinctly when spoken to in an ordinary tone. Best of all, **it has stopped my head noises**, which were a terrible aggravation. LEWIS W. MAY, Cashier, 100 Washington St., Chicago.

Write to or call (call if you can) at our Chicago offices for particulars of our personal test offer and list of other prominent endorsers who will answer inquiries. Physicians cordially invited to investigate aurists' opinions.

Stolz Electrophone Co., 1854 Stewart Bldg., 7th floor, Chicago.
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YOU decide whether to buy it or return it, and it costs you not one cent unless you keep it. Fully guaranteed. Try it ten days, then if you are fully satisfied with the benefit received, buy it; otherwise return it and we will pay the express charge. **Send no money now**—Just fill in and mail the coupon. This offer and special price is for a limited time only, so write at once.

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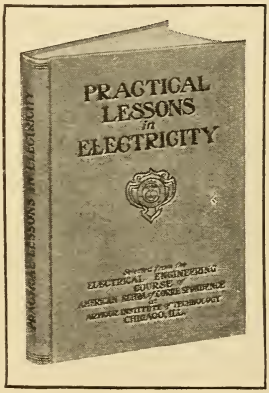

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JUST HALF PRICE **PRACTICAL LESSONS IN ELECTRICITY** is a working guide to the fundamental principles of electrical science and approved American practice by the following well known authorities on electricity; F. B. Crocker, E. M. Ph. D., Head of Department of Electrical Engineering, Columbia University, Past President, American Institute Electrical Engineers; H. C. Cushing, Jr., Consulting Electrical Engineer, and Lawrence K. Sager, S. B., M. P. L., Patent Attorney and Electrical Expert.

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275 pages; 6½"x9¾"; handsomely bound in red cloth with 150 illustrations.

No one interested in electricity should be without it. **ACT AT ONCE** and get this book for **half price.**

SPECIAL **So many requests have been received to extend our Special Offer to give one years' subscription to POPULAR ELECTRICITY and "Practical Lessons in Electricity" for $1.25 (Canadian $1 60 Foreign $1.75) that we have decided to extend it another thirty days, but this offer positively expires with the special offer above described on May 15.**

WRITE TODAY

Use the coupon, state whether you wish subscription with book or book alone.

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Gentlemen:—Enclosed please find $..... for which send me

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Will you accept $5.00 a day for your services?

Whatever your present employment may be—whether you are a man or a woman—this offer is open to you.

You can establish yourself in a **pleasant, profitable** and **permanent** business that will pay you more than **$5.00 a day** at the start—and will pay you as **much more** as you care to make.

You can learn this business in **less than a week**—and make **good money** while you are learning it. You will have practically no competition.

You Take no Risk Whatever

You will invest no money in this business until you are **absolutely sure** you can earn the money at it. You therefore **run no risk** of losing money. You are **paid well** for **all** you do.

You know the principle of the vacuum cleaner. It sucks up **dirt** and **dust** from floors, carpets, rugs, furniture, walls, woodwork, etc., and takes **all** the dirt and dust **out of the house**—quickly, easily, economically.

It makes housecleaning the work of **hours** instead of the work of **days**—and it does the work **ten times as thoroughly** as any other method.

How The Business Increases

Every housewife who has a rug, a room or a house cleaned by this process, is so **thoroughly satisfied** that she tells her friends about it.

You get **their** orders. They tell **their** friends—and you get **more orders.**

You get the work month after month, season after season, year after year. The more **customers** you get—the more **they** get for **you.**

Duntley Standard Vacuum Cleaners

embody **every principle** and **every improvement** known in the vacuum cleaner business—and combine all these advantages in a **portable machine,** weighing about 50 pounds, that can be easily carried from room to room, or house to house.

You can take one of these machines into a residence and remove **every particle** of dust and dirt, from **every room,** without taking up carpets or rugs—without removing furniture—without taking down curtains or portieres—and do it in **one-tenth time** it could be done otherwise.

What This Invention Means

Before the invention of the Duntley Portable Standard Vacuum Cleaner, this work could only be done with a big, cumbersome, costly wagon apparatus—yet these wagon outfits earned for their owners **immense profits.**

The Duntley Portable Standard Vacuum Cleaner does the same work that the big wagon outfits do, and costs only a fraction as much originally and much less to operate. It will therefore, pay you **far larger profits.**

My Pay From Profit Plan

I want one good, earnest, honest, active man or woman in **every** city or town—**no matter how small**—where residences are **lighted by electricty,** to engage in the Duntley Vacuum Cleaner business, on the "Pay from Profit Plan."

I will **establish** you in business—**show** you how it is done—enable you to make good money while you are learning it—and assure you an income of at least **$5.00 a day.**

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Let me Prove These Truths

I do **not** ask you to invest one dollar. All I ask is that **you** fill out the **coupon below,** and let me **prove to you** the truth of every statement here made.

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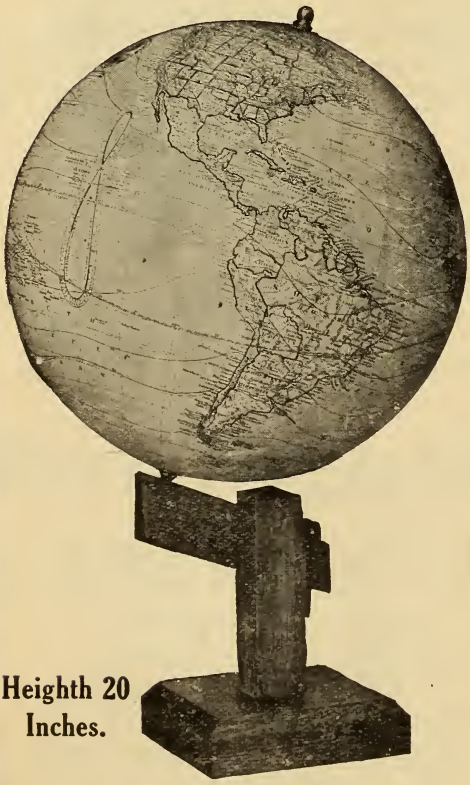

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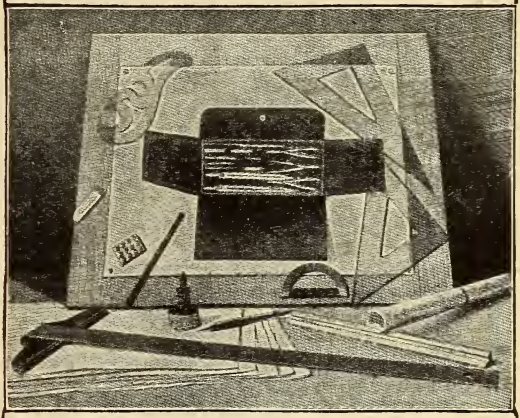

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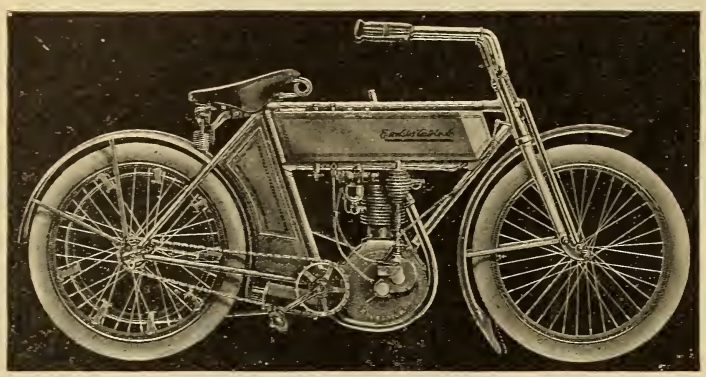

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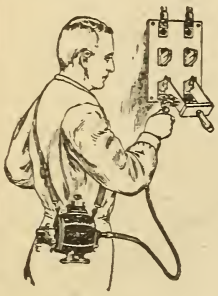

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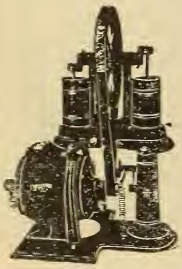

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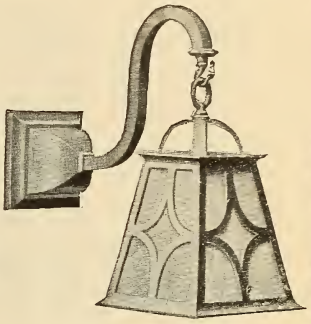

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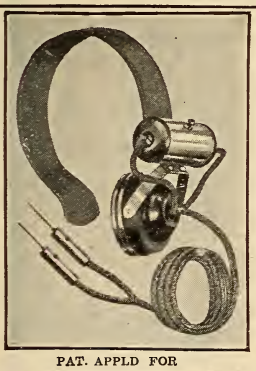

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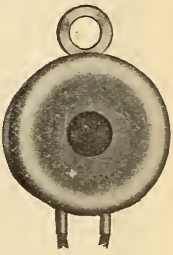

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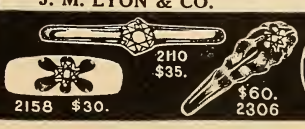

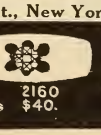

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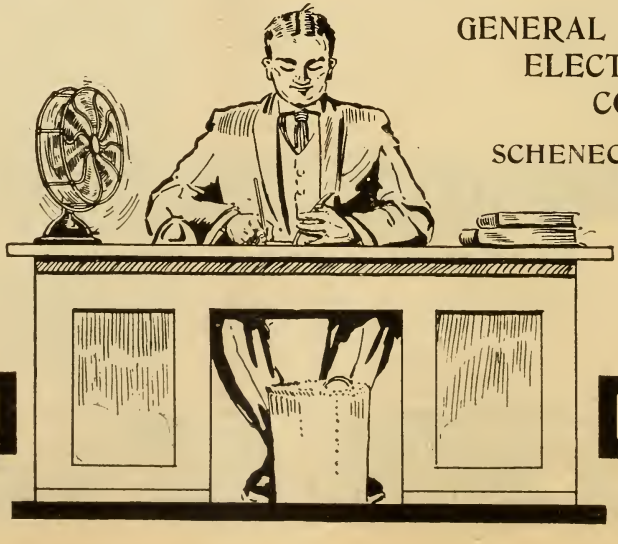

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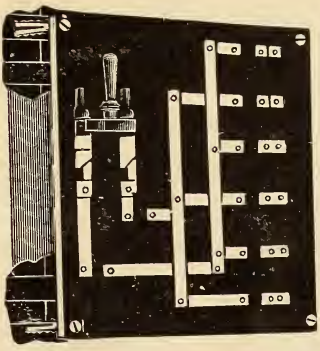

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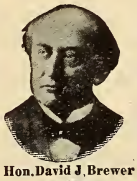

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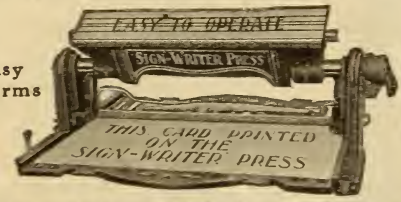

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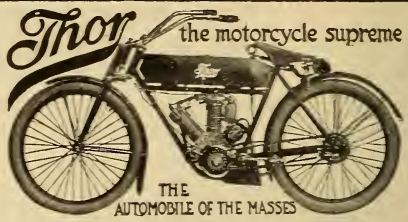

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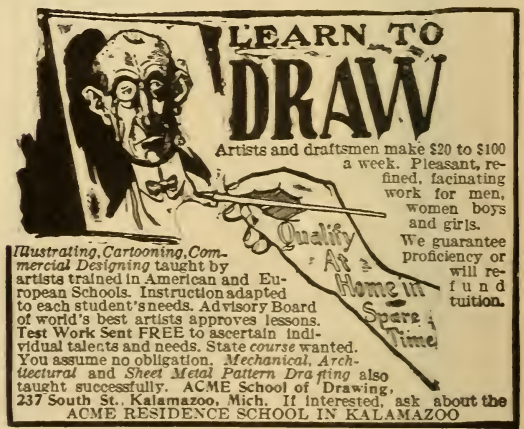

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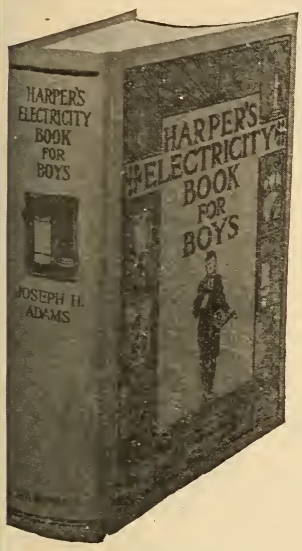

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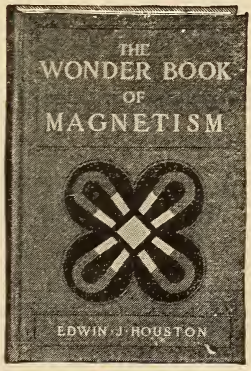

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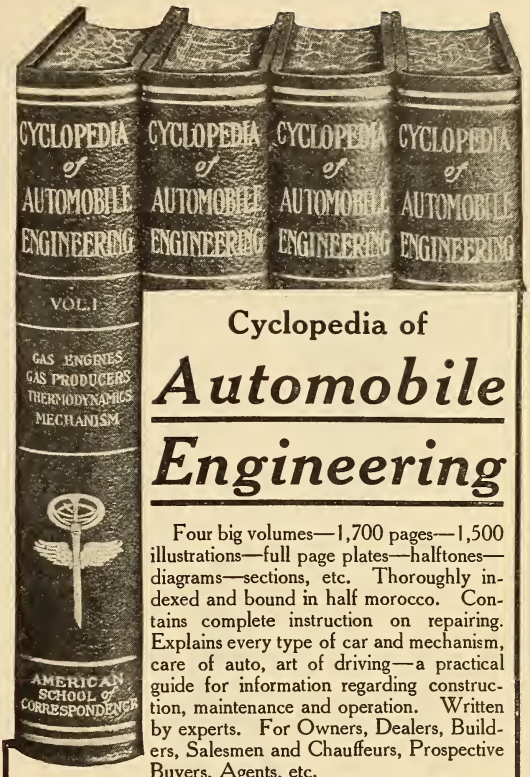

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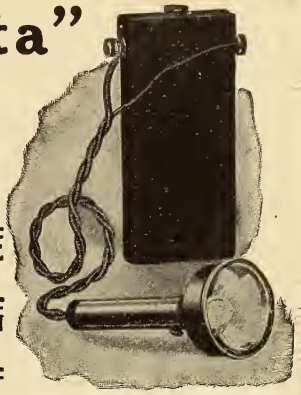

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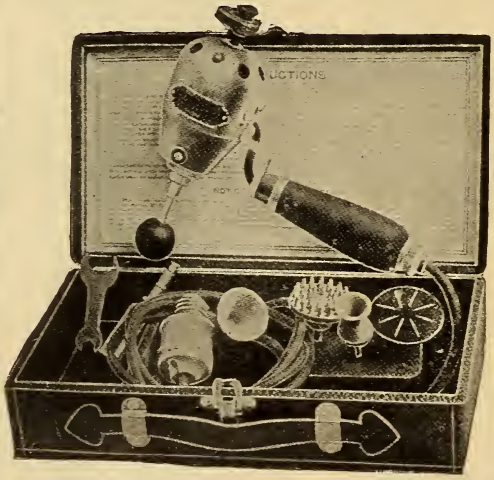

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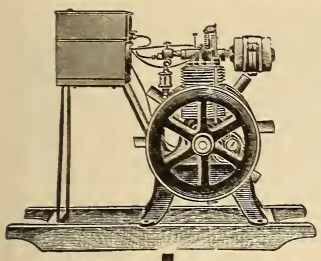

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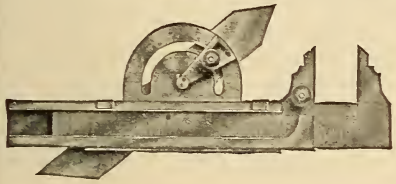

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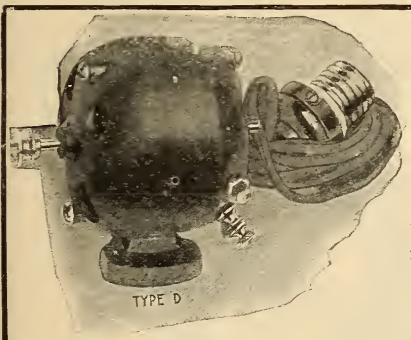

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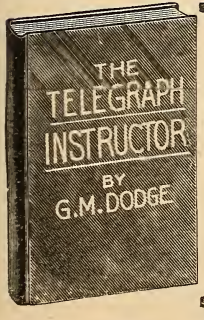

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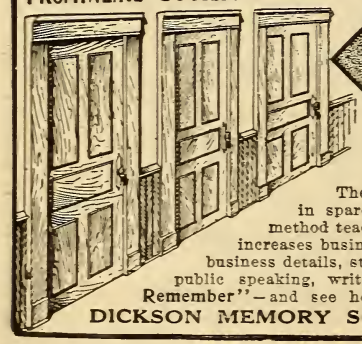

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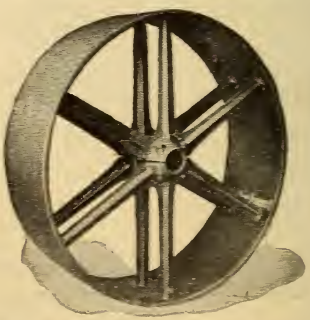

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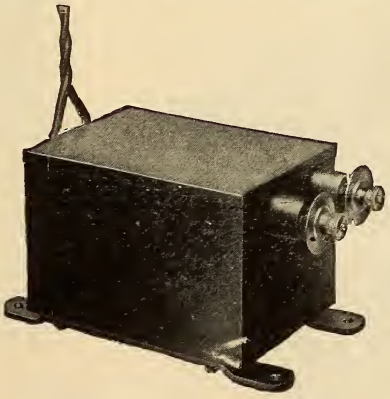

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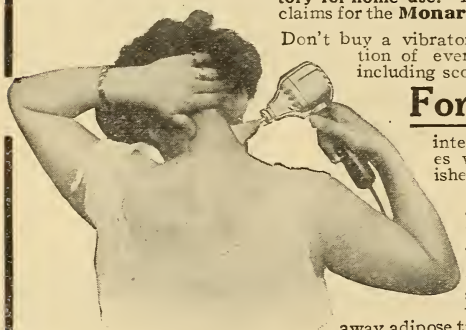

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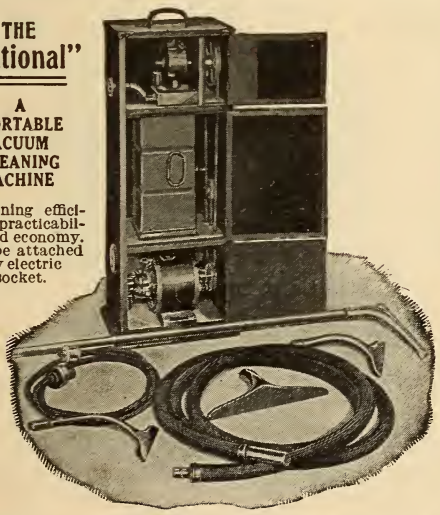

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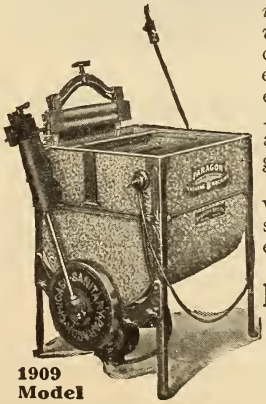

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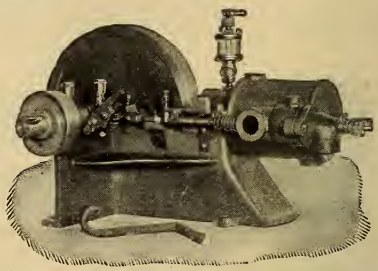

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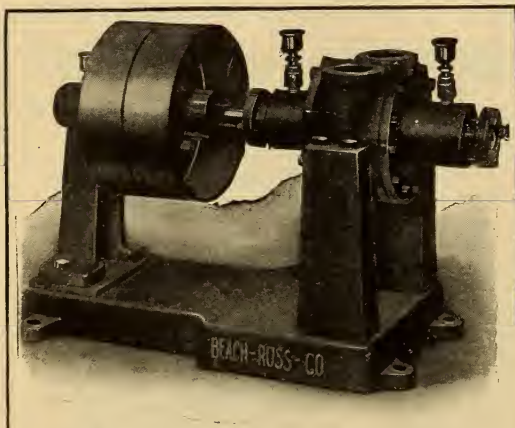

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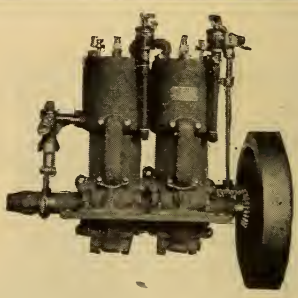

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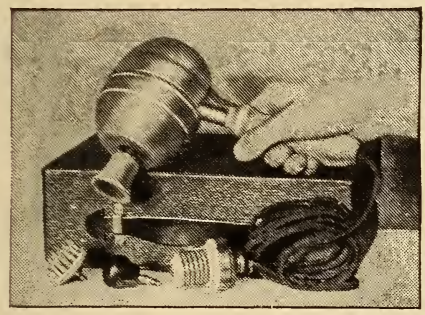

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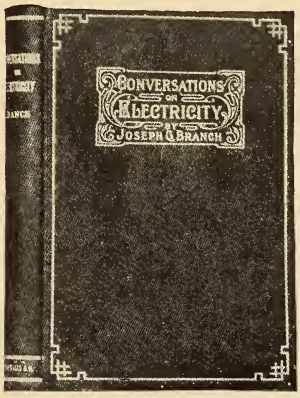

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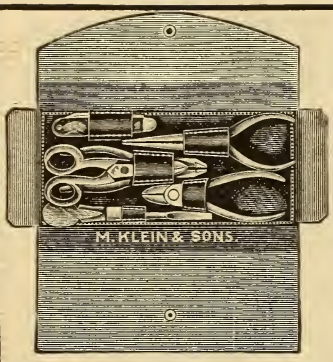

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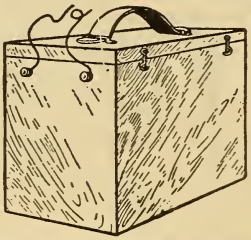

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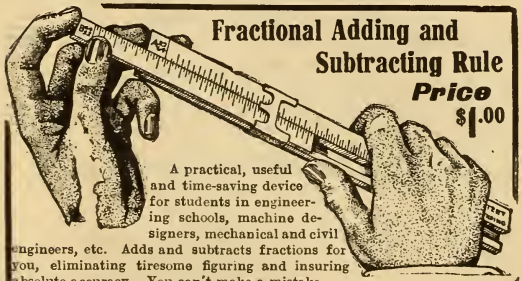

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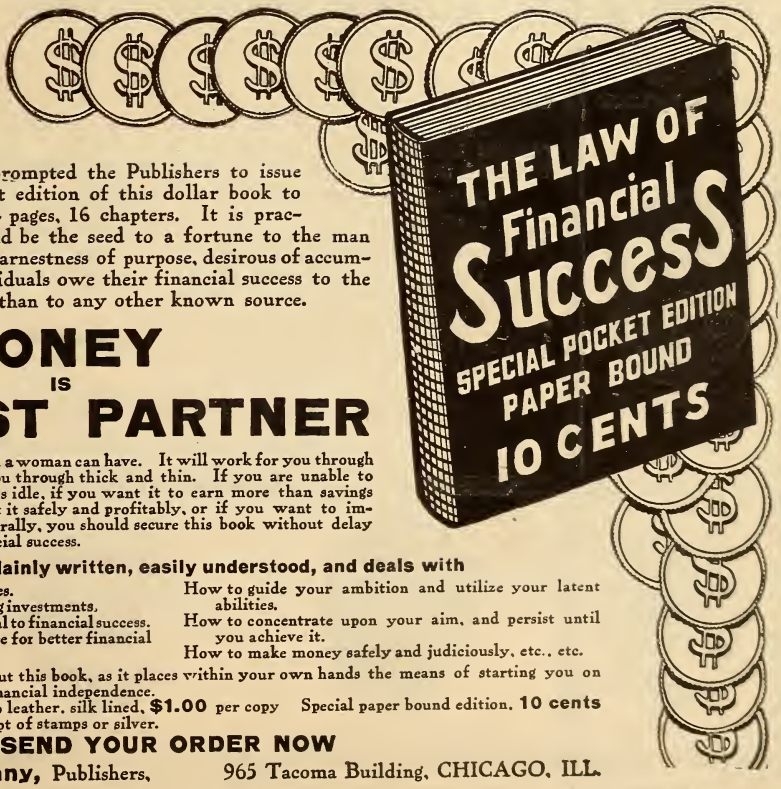

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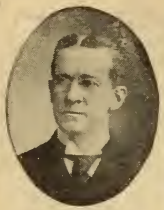
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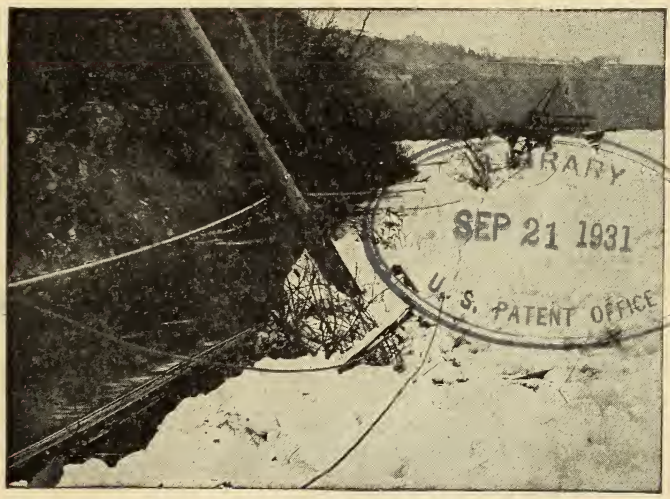

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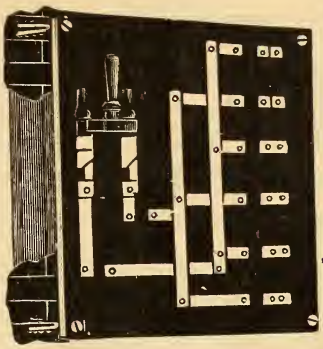

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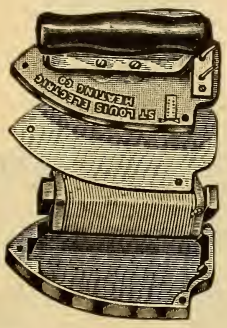

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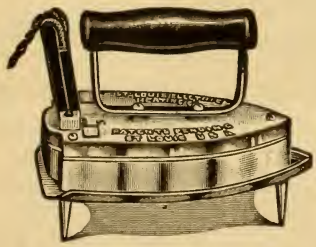

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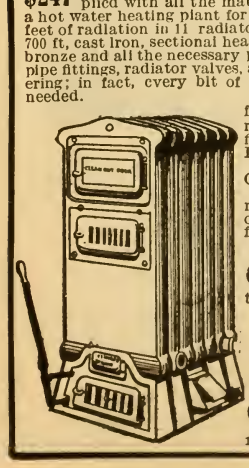
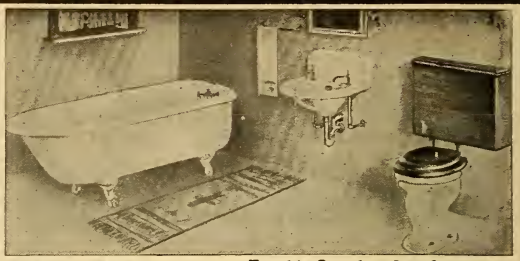




$39.00 For this Complete Set of HIGH GRADE BATH ROOM FIXTURES
We Sell Direct to the Consumer

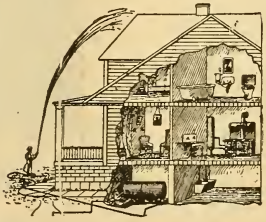
This is our No. 5 bathroom combination, regularly listed in our catalog for $45. We are making a special offer to readers of Popular Electricity on this of $39. The Bath Tub is 5 ft. long, 30 ins. wide, white porcelain enameled inside and over the rim, and is trimmed complete with full nickel trimmings. The Lavatory is cast iron, heavy white porcelain enameled and trimmed complete with full nickel trimmings. The Closet is high-grade, sanitary, vitreous syphon wash down bowl with polished oak copper lined tank and seat and cover to match. All parts high-grade. **This offer is for a limited time only.** Other Bathroom Outfits from $24.50 to $125.00

THE PROBLEM SOLVED

You can have Modern Sanitary Plumbing installed in your home at very low cost, for our "All Iron Pipe" System enables any handy mechanic, without previous experience, to do the work.

DON'T BE HELD UP

for an exorbitant sum in order to possess these conveniences, for we will sell you the material at lowest wholesale prices. There is no mystery about the pipe work for plumbing. It makes no difference—whether in a city, where you have running water and sewerage, or in the country, where you have to provide your own water system and dispose of your own sewerage, you can have these improvements. We will sell you all the material of all kinds needed, make you working drawings, and tell you how to do the work.



Pneumatic Water Supply Systems

We will furnish you with a complete pneumatic or air pressure water supply outfit that will furnish you running water the same as city water works. Prices range from $40 upward. We will furnish you complete house plumbing outfit like shown in this picture, including the pneumatic water supply system, the bath room outfit, the kitchen sink and range boiler and all the pipe and pipe fittings to install from $125 upward.

JUST SEND US A PLAN

of your house for our free estimate of all the material required to put in these modern conveniences.

READY ROOFING

95 Cents per Square

Galvanized Rubber and Asphalt

We offer the entire lot of factory mill ends of prepared roofing strictly high grade, brand new, at less than cost of manufacture. There are from two to four pieces of galvanized, rubber or asphalt roofing to each roll of 108 sq. ft. This is $2 and $3 grades of roofing.

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Only $1.50 per hundred sq. ft. Fifty thousand squares of steel roofing, size 2 ft. 6 in. wide by 5 ft. 6 in. long (30x66 in.)

These sheets were used about 30 days in connection with the manufacture of soap. This material was never exposed to the weather and was never nailed. Every sheet is clean and free from nail holes and practically as good as new. EXTRA HEAVY. From 24 to 28 guage.

PRICE FLAT PER 100 SQ. FT. - $1.50
CORRUGATED PER 100 SQ. FT. - 1.75

CENTRAL M. & S. CO., CHICAGO.

The hot water heating plant purchased from you for my 11-room house, which I installed, following your plans, is thoroughly satisfactory. I have no difficulty in heating my house from 75 to 80 degrees in coldest weather. I expect to purchase quite a few plants from you this year to install in other houses. I also bought a pneumatic water supply system and bath room outfit with the necessary piping to connect it all up. I did all the work myself and the entire outfit works perfectly. Five to 10 minutes pumping twice a week supplies all the running water we want. I think almost any man would be able to follow your plans and do the work.

WILLIAM GESSERT, Menominee Falls, Wis.

CENTRAL M. & S. CO., CHICAGO.

I am much pleased with the hot water heating plant, the pneumatic water supply system, the bath room outfit and kitchen sink that I purchased from you for my home. Every part of this plant is thoroughly satisfactory. We have extremely cold winters here; but the heating plant heats the house perfectly. In purchasing this from you, I saved about $400.00.

Very truly yours,
JOHN GASMAN, Bark River, Mich.

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POPULAR ELECTRICITY

IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. 11. JUNE 1909. No. 2.

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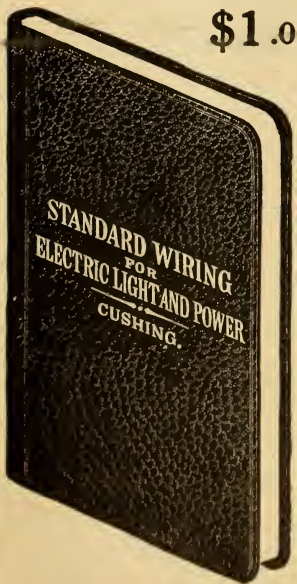

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Publisher's Page

What Volume II Means to the Advertiser and Publisher

It is generally conceded among advertisers of national repute that a publication does not carry prestige until after its first year. We have lived with the idea in view that Popular Electricity would become more permanent in its advertising pages after we had passed through this infancy stage.

We offer an advertiser today this so-called, long-looked-for, year-old prestige with a circulation of 75,000 copies and advertising pages numbering 64 net—each and every advertiser in these pages satisfied with the results produced.

Continued patronage by advertisers has been our experience during the last year. From the first one-inch advertisement of $3.60 that appeared in issue No. 3, there has been nothing but a steady, healthy growth and a constantly increasing enthusiasm among our advertisers.

We expect to do big things in the coming year, and we can do big things for you. You can assist us in accomplishing this end and the way to do it is to advertise.

MOVING DAY

May 1st is the appointed day for change of domicile among city dwellers, particularly those of us who are addicted to the flat habit—"cave dwellers" as a waggish student of modern Sociology terms us. A considerable number of our subscribers changed their location on May Day. *Some of them* were thoughtful enough to notify us of the fact. Others contented themselves with notifying their postmaster (or he found it out, he's good at such things) and after this issue is mailed Uncle Sam's notices will come pouring in to change certain addresses for future deliveries. Still others—too many to suit a publisher—failed to notify us or their postmaster and the result will be the return of their magazine with a notation "moved, left no address." Consequently we will have to "kill" such names on our list, until receipt of complaint, or non-delivery of magazine, which is sure to come later. Often the subscriber in such case naively assumes that we should have known of his change of address; takes it for granted, possibly, that we would get it "by induction."

To be sure, we will adjust such complaints and re-mail issues you have missed—if we have them—but we will appreciate it if you will help us to keep your Popular Electricity files complete by notifying us, a month in advance if possible, of any change in your address, giving both old and new location.

TROUBLE ON THE LINE

Sometimes, of course, mistakes on our part occur. In spite of the greatest vigilance they are to be expected in a large mailing list. Here again our subscribers will confer a real favor if they will advise us promptly. If your magazine fails to arrive within five days of the regular time, let us know, but try to do it good naturedly. We mean well. Here is a complaint that is a classic in its way, the result of an expiration notice sent in error.

> "There must have been trouble on the line somewhere, for I certainly fused up my sub. with two subscriptions on Dec. 18th, '08, which should have carried me along without mishap for two years from the date of first wiring, though your letter of the 21st inst., indicates that you will remove my meter in the month of June unless I come forward with another fuse. If you will kindly go back over the line, I think you will locate the trouble about Dec. 31st, '08 for that is the time you forwarded me a card stating that you would extend my current for an extra year. Kindly let me know if you can locate the short, for I am passionately fond of a hot wire, and as every number seems to be getting warmer, I am anxious to know that the trouble has been found. I am more than pleased with your efforts at the central station, for it keeps up the voltage at the farthest point of distribution, giving excellent light in the darkest places."

It is a pleasure to have our attention directed to an un-intentional oversight in such a good natured fashion by one who seems so well versed in the phraseology of the science we are exploiting and who tempers his rebuke with such sincere expressions of hearty approval and appreciation of our efforts to provide a magazine second to none in its field.

WATCH THIS PAGE

RENEWALS. When your subscription expires, you will find a renewal blank enclosed here. You should fill out and return same with remittance at once, to avoid missing a number. Positively no copies will be mailed on any subscription after same expires unless renewed, and we cannot agree to begin subscriptions with back numbers. The date on wrapper of your magazine shows the issue with which your subscription ends.

CHANGE OF ADDRESS. Notify us promptly of any change in your address, giving both the old and new location. Since each issue is printed a month before the date it bears, we should be notified at least four weeks in advance, in order to make the necessary change in our records.

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When you buy a piano at retail you pay the retail dealer's store rent and other expenses; you pay his profit and you pay the commission or salary of the agents or salesmen he employs. **We make the WING PIANO** and sell it ourselves. **We employ no agents or salesmen.** When you buy the WING PIANO you pay the actual cost of construction plus **only** our small wholesale profit. This profit is small because we sell thousands of pianos yearly. Most retail stores sell no more than 12 to 20 pianos yearly and must charge from $100 to $300 profit on each. You can calculate this yourself. These dealers get as much profit on their cheap pianos as on the standard high grade ones. As the cheap pianos cost less than half, they "talk up" and push the cheap pianos—but often call them high grade.

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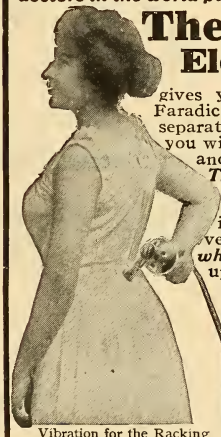

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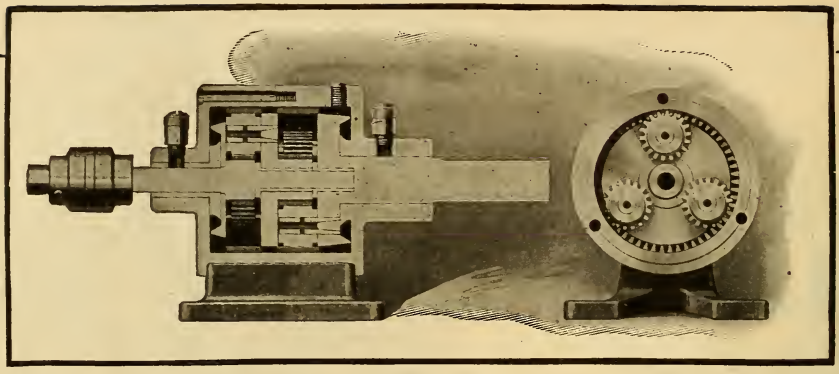

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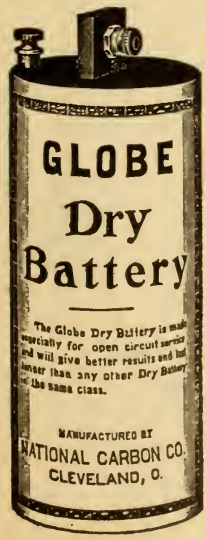
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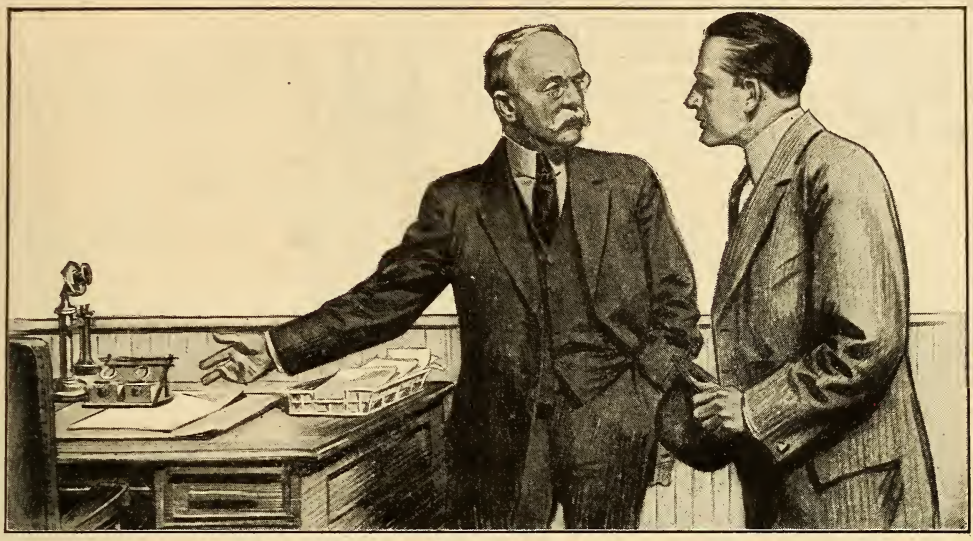

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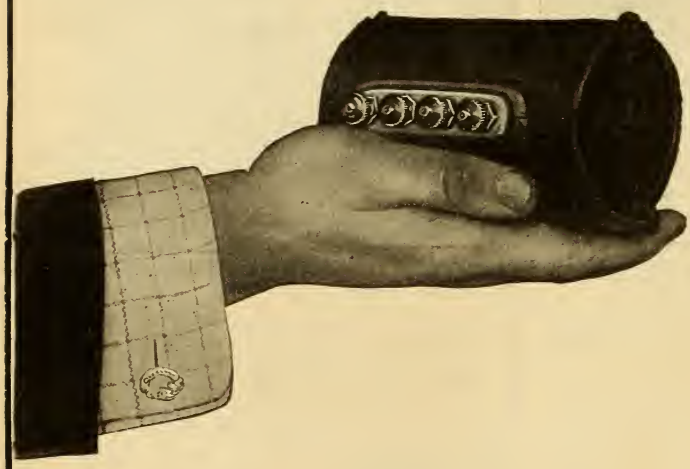

¶ This tiny device, called by electricians a transformer, is arranged to take electricity from the ordinary alternating current lighting circuit, changing the voltage from 110, or more, volts to the proper value for operating bells, buzzers, spark-coils, burglar alarms, miniature lamps, door locks, gas lighting and annunciator systems.

¶ This little transformer will operate on any lighting circuit, requires absolutely no attention, contains no moving or wearing parts and can be installed with an ordinary screw-driver.

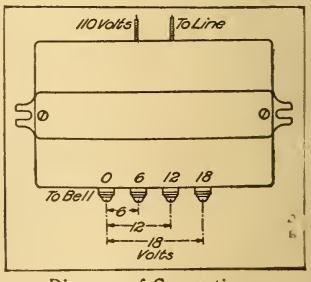

Diagram of Connections

¶ It saves the money now being spent for new batteries and eliminates all the work and bother when old batteries refuse to work.

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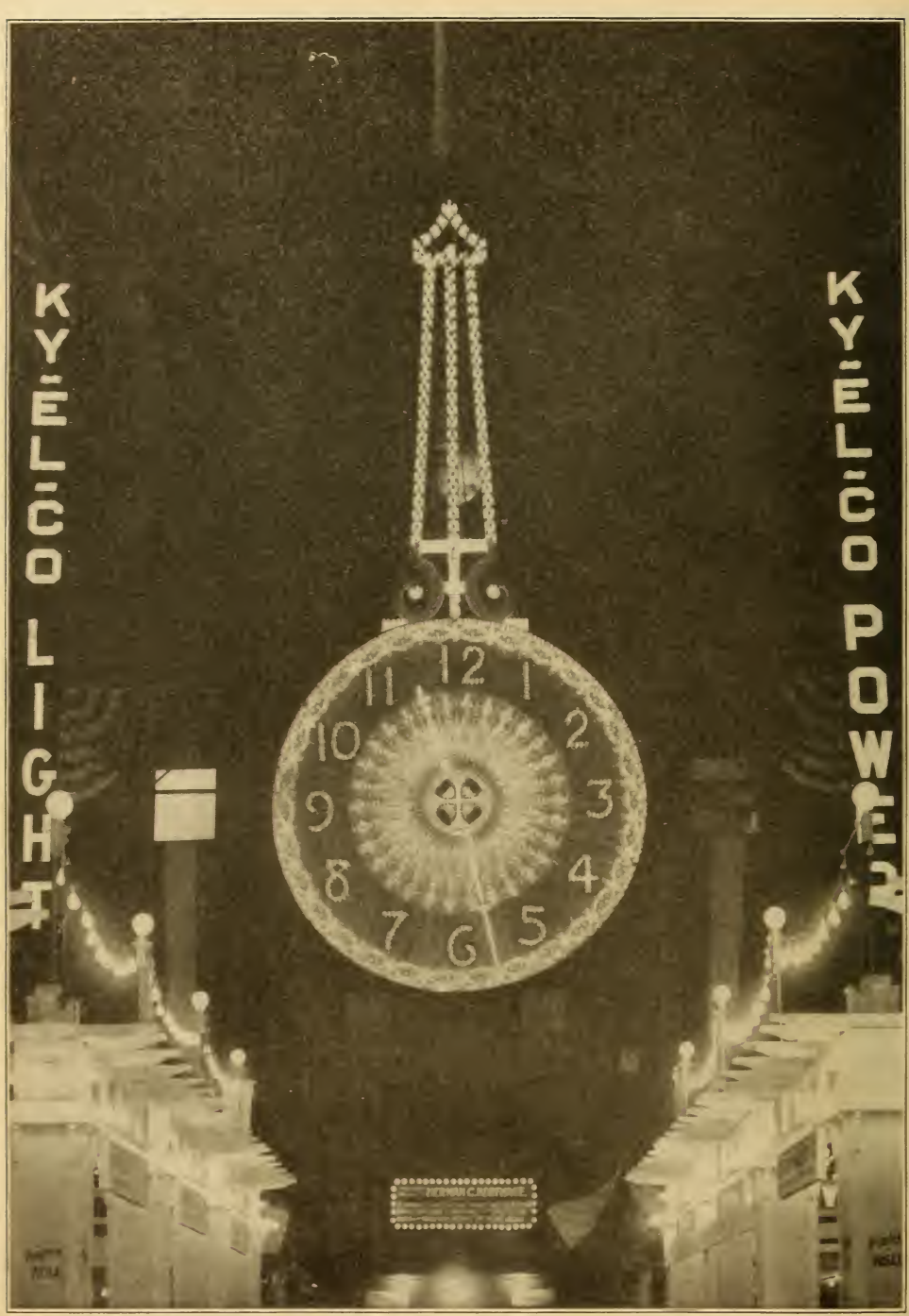

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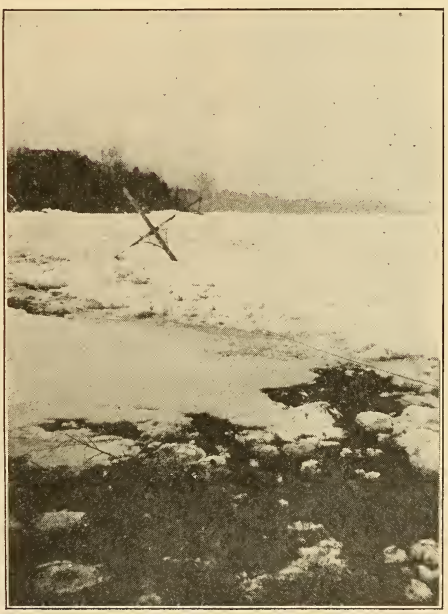
POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. II JUNE 1909 No. 2

ICE DAMAGE TO NIAGARA ELECTRIC PLANTS.

Never before in the history of the white man was there such a terrific ice jam at Niagara Falls as occurred during the month of April of this year. The hydro-electric power plant of the Ontario Power Company was shut down by being partly submerged due to the ice, and the other lower Niagara power plants of the Niagara Falls Hydraulic Power and Manufacturing Company were stopped from the same cause and this resulted in shutting down several plants depending on these power stations for electric current.

Peculiar conditions of ice, wind and water at Niagara Falls were such as to produce a jam in the lower river which has never before been equaled. The heavy and continuous winds up the lakes in February resulted in holding back the waters on Lake Erie and causing the phenomenal dry Niagara Falls which produced so much trouble for the hydro-electric power plants above the falls.

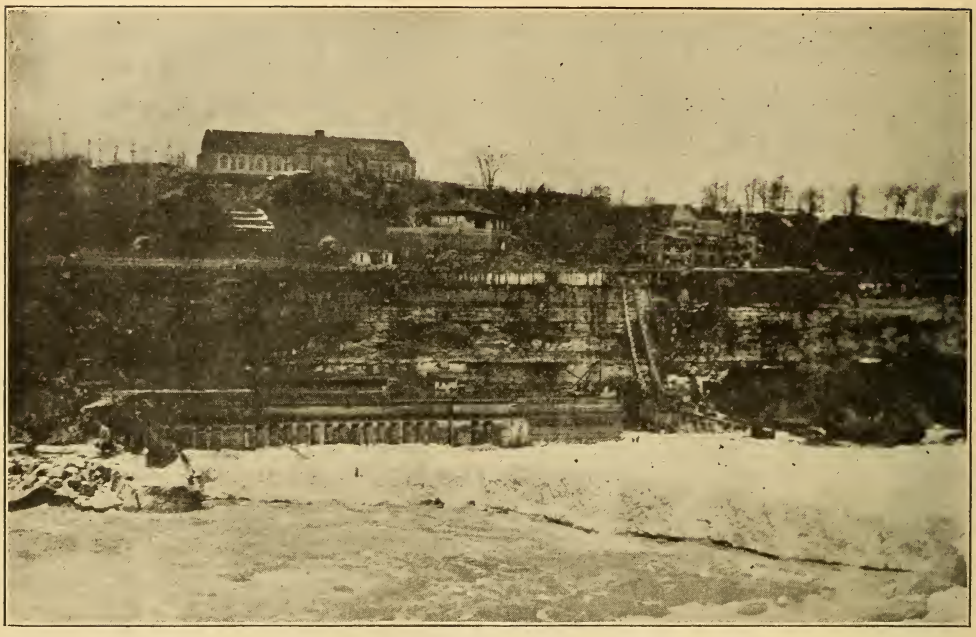


IN THE GRIP OF THE ICE.

The great jam in the Niagara Gorge was caused by the severe winds of the second week in April rushing up the Gorge. The conditions combining to produce this effect, were the high water in the upper river carrying large quantities of ice over the falls, and the heavy winds which were in a direction to hold the ice back in the lower river.

The wind sweeping up the ravine met the vast quantities of ice passing under the bridges and through the rapids and whirlpool causing it to become wedged against the banks at Lewiston and Queenstown forming a dam which raised the level of the water 40 to 50 feet above the normal and 20 to 25 feet higher than ever before recorded.

One of the illustrations shows the power plant of the Ontario Power Company and its transformer house on the bank above, on the Canadian side. It may be stated that the water raised so high as to enter the windows and doors of this power plant, completely shutting down the machinery for several days with disastrous results. The high-tension generators were partly submerged, and although the damage to the plant was not permanent the electrical machinery was put out of commission so that the power service on the transmis-



SHOWING THE PARTIALLY SUBMERGED PLANT OF THE ONTARIO POWER COMPANY.

sion lines on the American as well as the Canadian sides was discontinued for a time.

As soon as possible, arrangements were made for a high tension current supply from the other Canadian Power plants above the Falls temporarily for supplying the Canadian power users, while on the American side the 10,000 horse power gas engine power plant of the Lackawana Steel Company was utilized for operating the Buffalo and Ham-

ICE PILED FIFTY FEET HIGH BELOW THE CANADIAN FALLS.

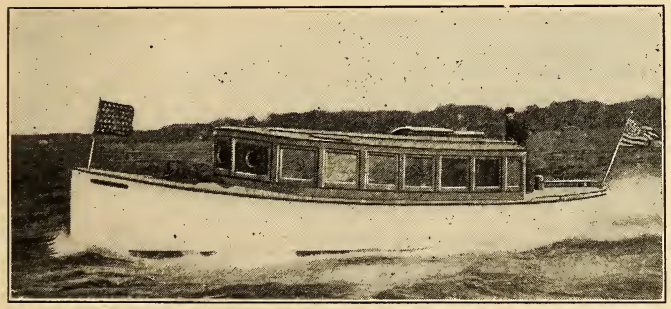
burg Electric Railway as well as for supplying the power users of the Ontario Power Company between Niagara Falls and Rochester.

The ice jam at the falls and the river filled with thousands of tons of ice which was piled 50 feet high on the Canadian side below the falls, wrecking the electric incline railway. The Maid-of-the-Mist was carried high and dry and its dock completely wrecked. The Great Gorge Electric railway on the American side was completely buried in some places 20 feet under the ice, its pole line and trolley wires wrecked and the tracks badly damaged, as shown in the picture on the front cover of this issue.

ELECTRIC CHARGING LAUNCH.

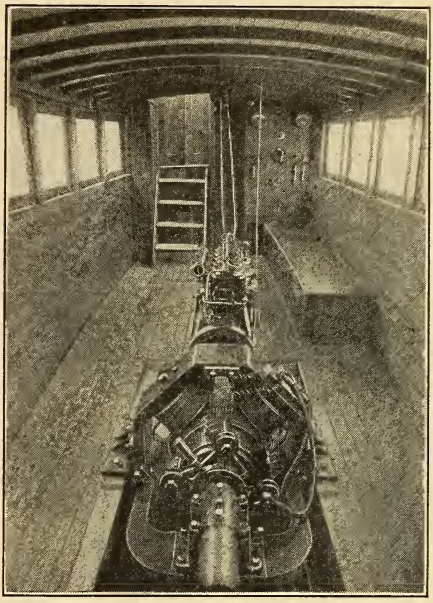
Electric power for launches and yachts has great advantages such as freedom from danger of fire or explosion, absence of heat, odor, vibration, noise, etc. But it also has the limitation that long distance cruising is impossible unless there are intermediate points where the storage batteries may be recharged.

With a view to overcoming the above objection, and to enable him to make long trips independently of charging stations on shore, Mr. Benjamin Douglass, Jr., of New York, has had built for him a unique floating charging plant to be used as an auxiliary to his handsome electric yacht *Cascapedia*. It is the first craft of its kind and the builders believe that it solves the question of the use of electricity in large yachts, since it can be operated at full power for 100 hours on one filling of the fuel tank, thus enabling the yacht to make a trip of 2,000 miles before either craft would have to enter port.



By Courtesy of the Electrical World.
ELECTRIC-GASOLINE CHARGING LAUNCH.

The name of this unique little boat is the *Kilowatt,* and following completion, she was shipped to Palm Beach, Fla., where her owner used her during the winter. With the recharging launch as an auxiliary, the yacht *Cascapedia* is not dependent upon electricity ashore for charging her batteries.



By Courtesy of the Electrical World.
CHARGING OUTFIT OF THE "KILOWATT."

The *Kilowatt* is 35 feet long, nine feet beam and two feet draft. Her power equipment consists of a 40-horsepower six-cylinder gasoline engine, connected to the propeller shaft. It also drives a charging dynamo. The dynamo is so arranged that current can be generated while the boat is lying at anchor or when under way. The plant has sufficient capacity for recharging the yacht's batteries in three or four hours. The charging launch has a speed under her gasoline power of nine miles an hour and carries 400 gallons of fuel, on which she can be operated for 100 hours.

ELEMENTARY ELECTRICITY.

BY PROF. EDWIN J. HOUSTON, PH. D. (PRINCETON.)

CHAPTER XIV.—RADIO-ACTIVITY.

As yet we are far from having discussed all phenomena similar to those produced by X-rays. There are still more curious effects to be recorded. Bearing in mind the fact that the X-rays were emitted from those portions of the walls of the Crookes tube that were rendered phosphorescent by the bombardment of the cathode rays, it occurred to Henri Becquerel of France that possibly other phosphorescent substances might emit X-rays. In order to test this he placed a crystal of a uranium salt, i. e., uranyl-potassium sulphate, illumined by sunlight, on a sensitive photographic plate that was protected from the direct action of the light by being covered with several thicknesses of black paper. When placed in sunlight Becquerel found that the uranium salt emitted a radiation capable of passing through the opaque paper, and affecting the photographic plate.

To his great surprise, Becquerel afterwards discovered that the uranium compound did not require to be exposed to sunlight in order to produce this radiation; it also gave it out in the dark.

Becquerel afterwards found that this curious power of emitting rays in the dark was possessed by nearly all chemical compounds containing uranium, a chemical element that possessed a larger atomic weight than any of the other elements, i. e., 238.5.

Briefly, Becquerel's discovery was as follows: Various substances, all of which in his early experiments contained the element uranium, emitted in the dark, without any prior exposure to light, peculiar radiations or emanations that resembled the X-rays in their power of rendering non-conducting gases through which they passed sufficiently conducting to permit them to gradually discharge insulated charged bodies; of readily passing through substances opaque to ordinary light; of exciting fluorescence or phosphorescence in bodies on which they fell, and of affecting photographic plates.

The peculiar rays thus discovered by Becquerel in the uranium minerals are generally known as the uranium rays. They are, however, sometimes named after their discoverer, the Becquerel rays. The ability of these substances to thus throw off or emit these rays is known as radio-activity, and the substances are known as radio-active substances.

A careful study of the uranium salts by Becquerel and others, as well as of a mineral known as uranite, or pitchblende, from which metallic uranium is obtained, soon led to the discovery of certain elements whose radio-activity is far greater than that of uranium or any of its salts. The cause of this greater activity was apparently to be attributed to the presence of some especially active material. Investigations soon led to the discovery of new chemical elements known as thorium, polonium, actinium and radium. The rays emitted by all these substances possess properties similar to those of the uranium rays. In order to distinguish them from one another, they are known as the thorium rays, the polonium rays, the actinium rays and the radium rays.

Of all the above substances, radium possesses the power of emitting this radiation to an extent far in excess of any other substance. Radium exists in very small quantities in pitchblende, and other uranium minerals, from which it can only be separated with great difficulty. It so closely resembles barium that it is very difficult to separate the two substances. That radium is a chemical element, however, is shown by the fact that it imparts a crimson color to the bluish flame of a Bunsen burner, while barium imparts to it a green color. Moreover, radium possesses marked radio-activity, while barium does not.

Some idea of the small quantity of radium present in ordinary pitchblende may be formed from the fact that Professor and Madame Curie, who first obtained this element from the mineral refuse from which uranium had been extracted, have estimated that it would re-

quire no less than 5,000 tons of this refuse to produce a kilogramme (2.2 pounds) or 1,000 grammes of radium.

But radium possesses another property far more remarkable than its peculiar radiation. Like the uranium salt, it is able continually to throw off the energy existing in its peculiar way independently of any source of energy from without. The amount of this radiation has been carefully measured. A single gramme of radium is capable of continually throwing off an amount of energy sufficient to melt its own weight of ice per hour.

Or, putting it in another way, a radium salt is continually emitting an amount of energy which is capable of vertically lifting a piece of matter of a weight equal to its own, continuously against the force of gravity, at the level of the sea, at a rate of ten meters (39.3 feet) per second.

When first observed, this apparent disobedience of radium to the law of the conservation of energy referred to in a preceding chapter naturally occasioned no little surprise, but as soon as it was discovered that the liberation of energy was accompanied by the breaking up of the atoms of the radio-active substance into particles called electrons or corpuscles, particles far smaller than ordinary atoms, it was understood that the disobedience to the law of the conservation of energy was only apparent. In other words, a greater amount of energy is evidently charged on the so-called atoms of matter than had before been supposed.

In order to understand this, let us again refer to the heat emitted continuously by a mass of radium. Before the discovery of radio-active elements, the heat produced by the combustion of a sufficient weight of hydrogen and oxygen to form one gramme of water had been carefully measured and was found to be greater than that given out by equal weights of any other known chemical elements. The total heat energy, however, emitted by the complete disintegration of a single gramme of radium is one million times greater than that involved in the combination of hydrogen and oxygen sufficient to form one gramme of water. In other words, there exists an enormous store of energy in a latent condition in the so-called chemical atoms of radio-active materials, that would never have been recognized had not the chemical elements been undergoing gradual chemical disintegration.

Radium rays are moreover capable of effecting a sensitized photographic plate in a manner similar to X-rays. The process is ordinarily quite slow unless

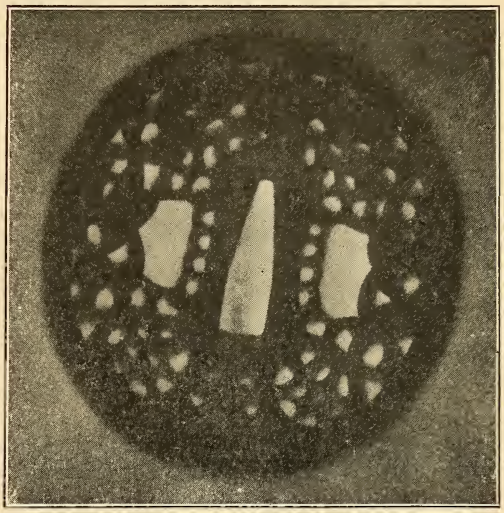


FIG. 91. FROM A PHOTOGRAPH TAKEN BY RADIUM RAYS.

the radium salt is very concentrated, producing powerful rays. Fig. 91 is reproduced from a radium photograph or radiograph, as it is called. In this case the article photographed was a metallic disk with a perforated design which shows in the white portions of the picture. The dark portions are metal. The disk was laid upon a photograph plate in a perfectly dark room and the radium salt, which consisted of pure radium bromide and very powerful, was held about six inches above the disk, the exposure being but a few minutes. The picture is not as clear as the ordinary photograph owing to the fact that there was no focusing arrangement, as is the case when a camera is used.

Let us now inquire how it is that a radio-active element such as radium is able continuously to emit its peculiar radiation. As a result of careful investigations made by many physicists, it is

now generally believed that, like all other radio-active elements, such as uranium, thorium, polonium, actinium, etc., radium is constantly undergoing atomic explosions whereby fragments of different sizes are thrown off; that these substances pass in all directions from the material in straight lines, carrying with them small electric charges; that their power of penetrating ordinary matter is due to their small size, the particles passing not through the molecules or atoms of gross masses, but through the spaces between them.

It might be objected to this explanation, that if a radio-active material is constantly throwing off its particles, it should soon undergo an appreciable decrease in weight. But the particles it throws off are so exceedingly small and the atomic explosions or disintegrations go on at so slow a rate, that it would require hundreds if not thousands of years for the loss to be sufficiently great to be recognized by an ordinary chemical balance.

It has been estimated that in the case of uranium and thorium, the change in weight goes on so slowly that it would require at least one million years to permit the difference in weight to be detected by a delicate chemical balance. Even in the case of radium, in which the change is far more rapid, it has been estimated by Rutherford and others that at least 1,500 years would be required to reduce a given mass of radium to half its original mass, and even at the end of 30,000 years, at least one one-millionth part of the mass would still remain. Nevertheless, since even this slow change is short when compared with the life of the earth, it is evident that radium must be continually produced, since, otherwise, all the radium would long ago have disappeared.

It is believed that an atomic disintegration of matter is constantly going on; that at certain stages in this disintegration the more markedly radio-active elements are produced, such as uranium and radium. Taking, however, the case of radium, the most active of the radio-active elements, it is evident that by its breaking up there are produced a variety of other chemical elements. One of these has actually been detected; that is, the element helium, which had been proved to exist in the atmosphere of the sun before the discovery of radio-activity.

The radio-active elements like radium are not believed to break up instantly into the element helium. On the contrary, in the case of radium, its atomic explosions must produce new elements not only in the particles thrown off from the atoms, but in the remnants of the atoms. Neither of these substances can continue to be radium, since they do not contain sufficient matter to form radium atoms. Nor is it believed that, as in the case of radium, helium is produced by the first set of atomic particles that are thrown off by the exploding atoms, but by what are known as radium-emanations.

The first explosive disruption of the radium atom produces a radium emanation in the shape of a gas. There are, however, other emanations known as radium emanations, A, B, C, D, and E, all of which are solids. The time required for one of these emanations to pass into another varies from a few minutes to several years.

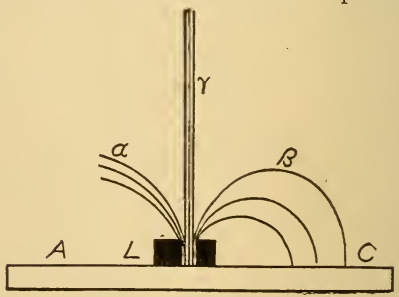


FIG. 92. METHOD OF DEMONSTRATING THE THREE KINDS OF RADIUM RAYS.

It will be seen that the theory of radio-activity as above given is contrary to the old belief that the atoms of matter are the ultimate or smallest particle in which matter can exist. This theory would rather regard all matter as consisting of a single kind of material, the difference in the so-called chemical elements being due to the differences in the number and groupings of this elemental matter.

The most important discovery that has been made concerning the rays thrown off from all radio-active elements is that they are all capable of producing three

different types of radiation. If a small quantity of radium salt is placed at the bottom of an open narrow cylindrical lead vessel (L), Fig. 92, the radium rays can pass freely out from the opening at the top. Now these rays, like the rays emitted by all radio-active substances, consist of the α rays, the β rays, and the γ rays. Ordinarily these rays will pass out commingled or associated with one another. If, however, a strong magnetic field is applied at right angles to the plane of the sheet of paper, and directed towards the sheet, the three kinds of rays are separated from one another as shown. The γ rays continue in a straight line as shown without any deviation; the β rays are deflected to the right, moving through the circular path as shown, so that if (A C) represent a portion of a photographic plate placed under the vessel the β rays will produce an impression on it; the α rays are bent in the opposite direction and also describe a part of the arc of a circle, but are rapidly absorbed after passing a short distance from the lead tube.

These three classes of rays possess the following properties; i. e.:

(1) The α rays consist of positively charged bodies that are thrown out with a velocity of about one-tenth that of light. They are readily absorbed, and are deflected by a powerful magnetic or electric field. The amount of this deviation, however, is smaller than that of the cathode rays produced in an ordinary vacuum tube under the same strength of field.

(2) The β rays are less rapidly absorbed and are far more penetrating in their character. They consist of negatively charged bodies that are thrown off with the velocity about the same as that of ordinary light. They are far more readily deflected than are the other rays, and appear to be identical with the cathode rays produced in a vacuum tube. These rays negatively electrify all objects on which they strike.

(3) The γ rays are extremely penetrating, and are not deflected by a magnetic field. They are capable of readily passing through most substances opaque to ordinary light, and appear to possess properties identical with very penetrating X-rays.

Zinc sulphide phosphoresces brightly under the influence of the rays from radium. If a screen covered with zinc sulphide is exposed to a radium salt, it will glow or phosphoresce brightly, and if the surface of this screen is examined by means of a magnifying glass, it will be seen that the light is not uniformly distributed, but comes from a number of scintillating points.

In order to demonstrate this property, Crookes constructed a piece of apparatus known as the spinthariscope, consisting of a small piece of metal dipped in a solution of a radium salt and fixed at a distance of several millimeters from a zinc sulphide screen placed at one end of a short brass tube and examined through a lens placed at the other end of the tube. When observed in this manner the zinc screen appears as a dark background dotted with brilliant points that appear and disappear with great rapidity. The appearance of the points corresponds to the successive explosions of the radium salt.

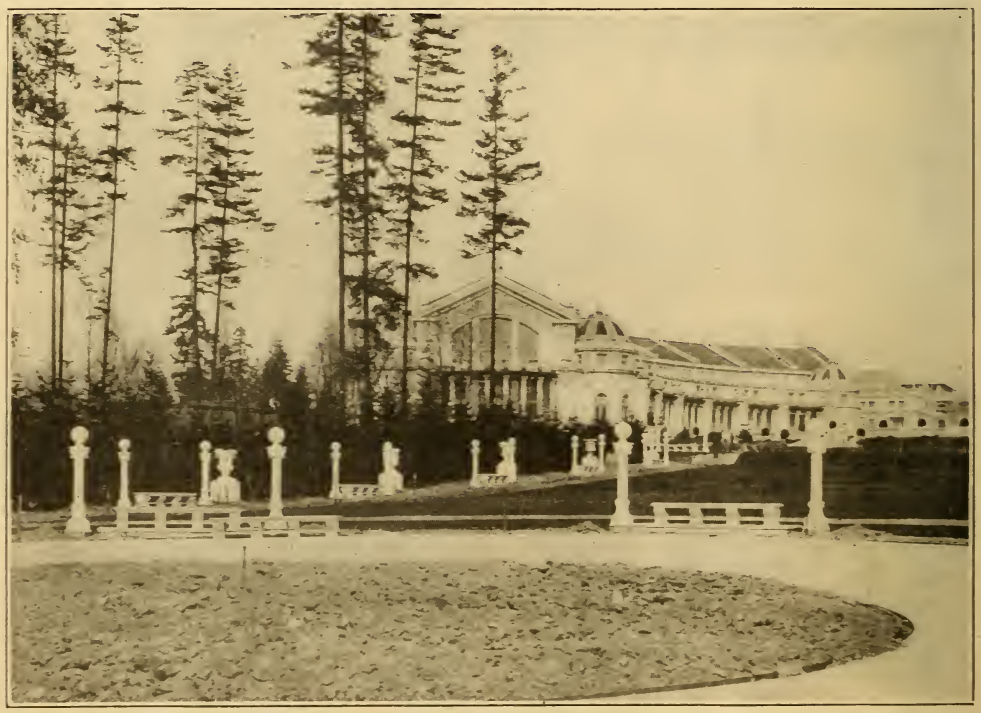
(To be continued.)

CURIOUS USE OF ELECTRIC LIGHT.

A curious use to which the electric light has been put was recently recorded in Pearson's Weekly. There has just been completed inside the Small Bird House at the London "Zoo," an arrangement of incandescent lamps, the object of the installation being to induce the tiny feathered inmates to take breakfast a couple of hours earlier than they otherwise would do. It is controlled by a switch outside the building, and each morning at six a keeper turns on the lights. This, of course, arouses the birds, who commence feeding forthwith, under the impression that day has dawned. The same dodge has been used from time immemorial for fattening quails for the London market. These birds feed only in the early morning, so, after being caught, they are kept in underground cellars, fitted with electric lights, which are periodically switched on and off. Every time the lights are raised, the quails start eating, going contentedly to roost when they are lowered. In this way a bird can be induced to eat as many as twenty-four breakfasts in one day.

ELECTRICITY AT THE ALASKA-YUKON-PACIFIC EXPOSITION.

Exploitation of Alaskan and Yukon territories and the fostering of trade on the Pacific Coast is the object of the Seattle exposition to be held this year. The University of Washington owns the Alaska - Yukon - Pacific exhibition grounds, which will be utilized by that institution after the exposition is over. One million dollars has been appropriated by the State of Washington for University and State buildings, the grounds



PORTION OF THE ELECTRICALLY LIGHTED GROUNDS OF THE SEATTLE EXPOSITION—MANUFACTURERS' BUILDING.

of which include 250 acres. The United States Government has also appropriated nearly three-quarters of a million dollars.

The site of the exposition is located in the suburbs of Seattle between Lake Washington and Lake Union, about five miles from the central district of the city. There will be 45 exposition buildings, including mines, manufacturers', engineering and machinery, as well as government, state and foreign pavilions and exhibit buildings, arranged about a central court with cascades, fountains and a geyser station.

In all modern expositions the feature which has attracted most attention and comment has been the electrical illuminations. Electricity made the Pan-American. It was the most-talked-of feature of the St. Louis exposition and in this respect Seattle is not going to be outdone, for although it may not be as great in size as other expositions it will make up in quality and artistic effects what it may lack in quantity, and this in spite of the fact that current must be brought from Snoqualmie Falls, 50 miles away.

The buildings will all be outlined with incandescent lamps of the frosted type, of eight candle-power, a total of about a quarter of a million being utilized. The State and Government Building will have about one hundred thousand lamps in service while the street and park lighting will employ an equal number.

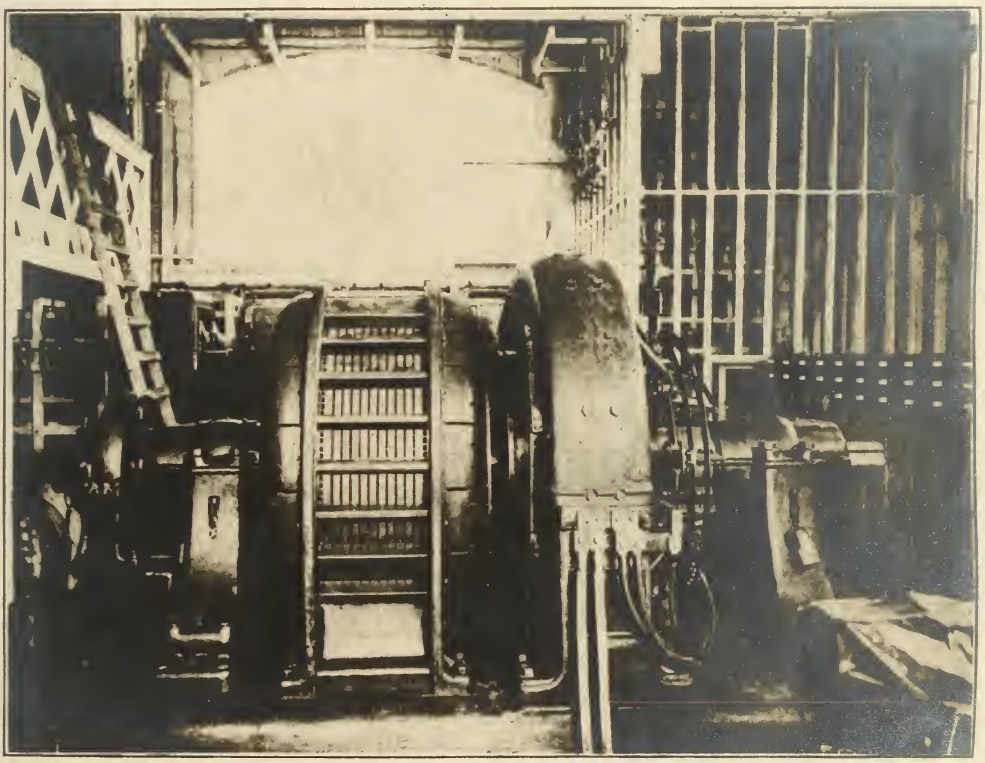
About fifty thousand lamps will also be used at the cascade court and geyser basin and on the buildings surrounding them. It was considered advisable to utilize electroliers about the grounds, as shown in one of the pictures, consisting of large balls on ornamental staff columns, with about 40 electric lamps of 20 candlepower each on the surface of each ball. In the park and on the shore of Lake Washington festoons will be provided along the paths and through the trees.

Alternating electric current at a very high voltage will be brought from the power station already at the Falls to a substation located on the grounds. Here it will be passed through transformers which will reduce the voltage somewhat and then into motor-generators. These machines consist of a motor and a dynamo, or generator, on the same shaft. The motor is revolved by the incoming current and turns the dynamo armature, which in turn generates direct current of a voltage suitable for operating the lamps and motors used on the grounds. One of these motor-generators is shown in the second illustration.

A new steam operated electric plant is also being built for the university buildings and the current developed by it will be used as an auxiliary to the "imported" electricity, in case of emergency.

During the entire exposition season a wireless telephone and telegraph station will be in operation, receiving messages from steamers entering and leaving Seattle. A pavilion with tower 100 feet in height of rustic design has been constructed near the main entrance. The antenna or aerial is supported from the top of a pole 50 feet high mounted on the top of this tower, giving a total height of 150 feet above the base.

A daily newspaper published in this wireless telephone and telegraph pavilion will contain news received by the wireless instruments and messages from the steamers arriving from and leaving for Alaska and the Yukon district.

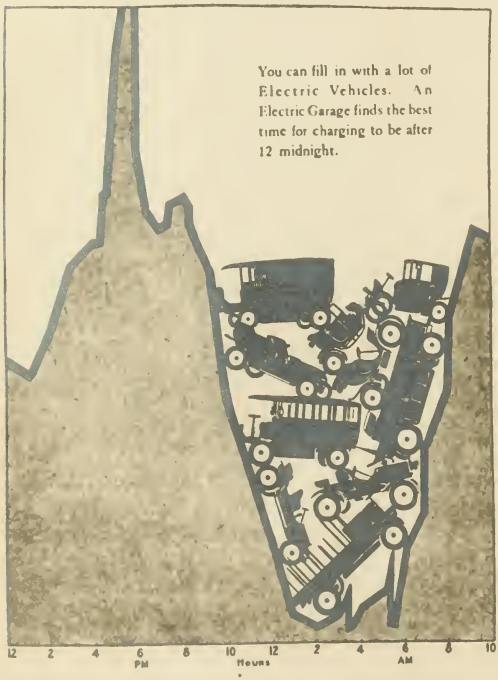


ONE OF THE MOTOR GENERATORS WHICH SUPPLIES CURRENT FOR THE EXPOSITION.

A STRIKING ADVERTISEMENT.

The accompanying diagram is a reproduction of an advertisement recently placed in a number of periodicals by a large storage battery manufacturing company and it illustrates in a striking manner one of the great problems in electric central station operation; namely, how to straighten out or equalize the daily load "curve."

The irregular black line which looks like a jagged mountain range represents in a general way the load on an electric plant between the hours of 12 o'clock


You can fill in with a lot of Electric Vehicles. An Electric Garage finds the best time for charging to be after 12 midnight.
12 2 4 6 8 10 12 2 4 6 8 10
PM
Hours
AM

A STRIKING ADVERTISEMENT.

noon and 10 a. m. the following day. Each point on the curve represents the load on the station at the particular hour designated on the base line immediately below that point. From 12 o'clock to 4 p. m. we see that there is a fairly heavy load due to motors and a few lights that are in operation during that portion of the day. Then, a little after 4 o'clock, if it be during the short days of late fall, winter and early spring, the people all over the city begin to turn on their lights and the curve rises sharply and runs up to a great height, but only stays there for a short time, when it begins to fall off as the consumers begin to turn off their lights and the motor service drops off. This high point is known as the "peak load" and is one of the worries of the central station manager, for, although money is received for the current sold during the peak, extra generating machinery must be installed to take care of it even though this machinery be idle the rest of the 24 hours.

From 8 p. m. the load falls off rapidly until a minimum is reached about 2 to 6 a. m. Then it begins to rise rapidly at 6 a. m., when the people are burning early morning lights, the factories are starting up, etc.

Only a glance at the diagram is necessary to show even the casual observer that there is a long period during the night when an immense investment in generating machinery is earning nothing for the company. Some electric companies get around this to a certain extent by installing great storage batteries which are charged by the dynamos during the slack periods of the day and which pour their current into the system during the peak load. In this way fewer dynamos may be used, and be made to work during the entire 24 hours. But the storage batteries are very costly, so the attendant saving in dynamo investment is counteracted to a considerable extent.

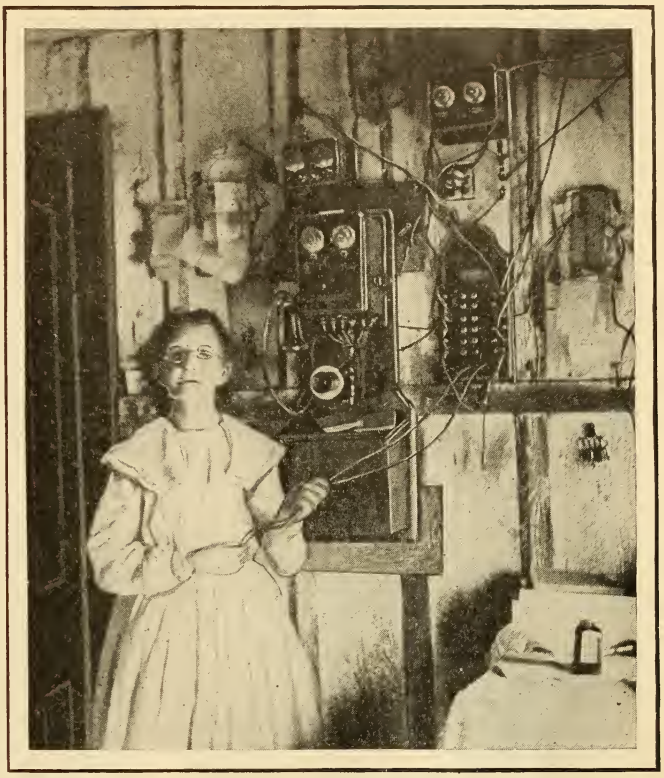
A more ideal condition would be to obtain commercial load which will come on during the hours of the night, and to forcibly remind central station managers of one kind of night load is the object of the advertisement. Electric automobiles and trucks of all kinds must have their batteries charged, which operation takes a number of hours. Therefore, the "ad" says, in language plainer than words, "Central stations, encourage the use of electric vehicles in your city, which will be charged at a time when your machinery is idle and which will help to straighten out your load curve."

The largest storage battery in the world has been installed at the Sixteenth Street Station of the New York Edison Company. The 150 cells have a capacity of 22,000 amperes for one hour at 120 volts. It will be used only in emergencies.

THE OLDEST TELEPHONE OPERATOR.

Much has been said by various owners of telephone systems relative to the precociousness of their offspring in connection with the operation of telephone switchboards, and numberless items on this subject have appeared from time to time in the various telephone publications. To date, however, so far as the writer is personally aware, says Mr. L. E. Knapp in a letter from Dallas, Texas, no claim has been made as to the age limit for employes for the operating department.

In this connection I think it likely that Mrs. Bynum is the oldest operator in the United States and possibly in the world. Mrs. Bynum, the mother of J. Fowler Bynum, owner of the Eagon Branch Telephone Company of Kaufman, Texas, every day operates a system having very nearly one hundred telephones. Mrs. Bynum is seventy-two years of age, notwithstanding which, she has a very good "telephone voice" and her hearing is most excellent. She recalls without reference to any bulletin the combination of rings for any subscriber who may be desired upon the system. She states that she enjoys the task of operating the switchboard and telephone system very much and that, in fact, without it she would find it rather hard to pass the time.—*Telephony.*



THE SWITCHBOARD AND OPERATOR AT KAUFMAN, TEXAS.

Nearly 300 miles of line for power transmission purposes is to be put up by the Ontario Hydro-Electric Power Commission in order to supply various towns and cities in Ontario with electricity generated at Niagara Falls. About a million pounds of aluminum wire will be used. The line will consist of three cables supported on towers spaced 550 feet apart.

ELECTRIC PLANTS IN THE UNITED STATES.

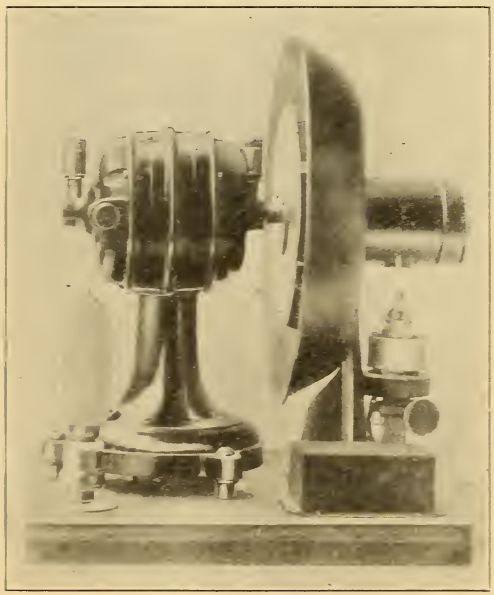
The census director has issued a preliminary report on the electric light and power stations of the United States. The statistics relate to the year ended December 31, 1907. The totals do not include isolated plants or plants that are idle or in course of construction.

The total number of establishments in 1907 was 4,714, an increase of 30.2 per cent over 1902. These plants gave employment to 34,642 wage earners and developed 5,858,121,680 kilowatt hours. These central stations supply current for 555,921 arc lamps and 41,807,944 incandescent lamps. The total horsepower capacity of the stationary motors served was 1,649,026. The increase in lighting during the five years was considerable but the greatest increase was in the numbers of motors supplied with current, a total increase of 276.5 per cent.

PRODUCING FRESH AIR BY ELECTRICITY.

BY M. M. HUNTING.

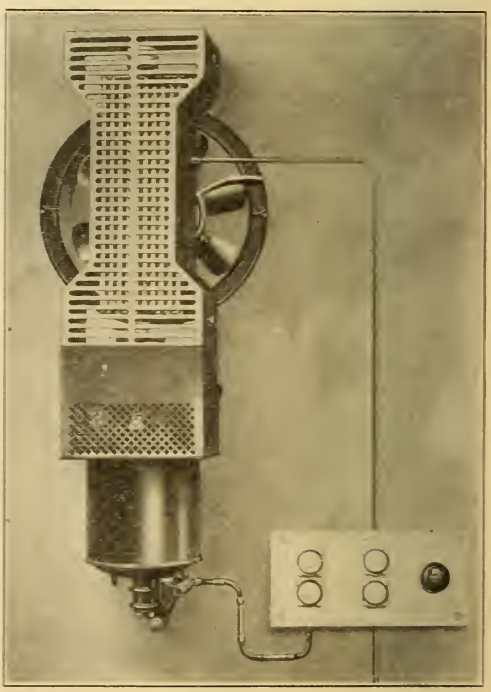
The city of Berlin is well known as a Mecca for scientists, and within the walls of its numerous laboratories many a problem of enormous scientific value has been solved. Not the least among these is the problem of producing fresh air by electricity. Much of the advancement in this line has been through the untiring efforts of a German, Dr. Fischer. He simply feeds a current of air into one of his electrical machines and in a twinkling out comes the germless air for us to breathe. His apparatus is called the "Ozone Fan," and is capable of concentrating the ozone in the atmosphere, and by means of a very high temperature this ozone is liberated and is re-distributed, with the proper amount of oxygen, and is made ready for us to breathe.



DR. FISCHER'S OZONE FAN.

The distinction that is so noticeable between the air we are forced to breathe in the average city and the sweet and pure air of the country, is due to the fact that this very same colorless gas, ozone, is present in larger quantities in the air of the country. We might say it is almost conspicuous by its absence in most cities, and for this reason also, germs rather prefer the city air, for ozone is a deadly enemy of these pests. This same ozone is found in small quantities in the sunlight, and we all know that the ordinary sunshine is more or less of a disinfectant, and for this reason health authorities urge upon us the habit of getting as much of it as we possibly can.

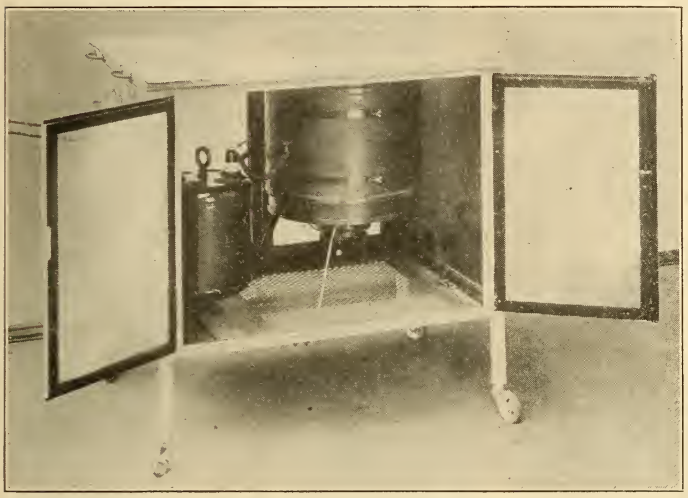
Dr. Fischer's ventilator produces this germ-slaughtering gas by taking advantage of an exceedingly high temperature, something like 2,000° C., and for this purpose the well known Nernst glower, applied so successfully to the Nernst lamp, adapts itself admirably. The fan draws the air current as it is needed, over the heated glower and it is thereby heated to the desired temperature. Now, it is immediately mixed with cold air and this sudden change causes the free gas to be liberated and made ready for further use.



OZONE WALL FAN.

Briefly, the apparatus consists of a small ventilator working upon the suction principle. The fan is placed inside

a funnel containing the Nernst glower, which is readily adjustable. This glower will not conduct current until it is raised to a certain degree of temperature, which temperature is obtained by using a heating coil. When the ventilator starts to operate, the first current is received by



PORTABLE OZONE FAN.

the heating coil. This continues until the glower is heated up to a point where it will carry current itself, when an electromagnet starts the fan-motor and at the same time the heating coil becomes disconnected.

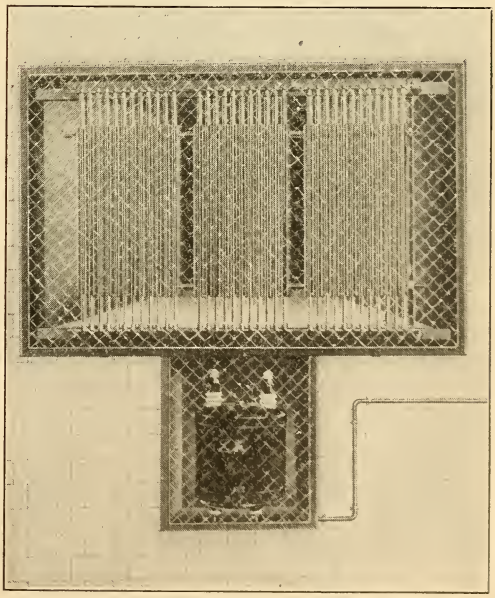
Now for a person to breathe undiluted ozone would be very detrimental to the body, for the pure gas acts in a highly damaging manner upon the mucous membrane. To overcome this disadvantage, the inventor has perfected his apparatus so that it is able to furnish this gas in the proper amount for breathing purposes, i. e., one-tenth of one per cent.

The fan overcomes the obstacle of furnishing a damaging amount of the gas by destroying a certain proportion and keeping a constant average strength of the mixture of common air and ozone.

The operating expense of this artificial fresh-air plant is very low when one considers the benefit derived by humanity from breathing such an atmosphere. It requires from 30 to 150 watts (one twenty-fifth to one-fifth horsepower) of current to convert from 35,000 to 175,000 cubic feet, and the machine takes one hour to do this amount of work.

There is still another design of ozone fan, manufactured by a German firm. This fan depends upon electric discharges, or flashes, to produce the necessary ozone. It resembles the electric ozonizer for the purification of water, from which Dr. Fisher conceived his idea, and which he has embodied in his ozone fan, described above.

The second ozone fan described is intended for air shaft installation, and on account of the nature of its makeup it is highly insulated. The fan drawing the air into the ventilator is fitted with iron rods and plates, alternating. Each pair of rods and plates being electrodes of a high tension circuit of an alternate current transformer, and for the sake of safety one terminal is grounded. The only noticeable evidence of what is taking place is a slight bluish streak produced between the plates and the rods.



OZONIZER FOR AIR SHAFT.

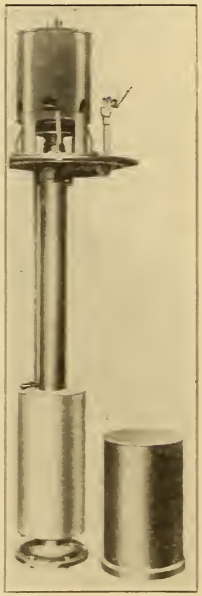
Aside from this difference the fan acts in a manner similar to the former one.

When very large areas, as an entire building, are to be ventilated the ozone is manufactured outside the building and after being thoroughly mixed with the proper amount of air, is then forced by means of a compressor, first into air pits and then by means of conduits, throughout the entire building.

This electrical form of aeration will prove a blessing in numerous places where the question of ventilation has long been a serious one, i. e., in subways, churches, theaters, and on board ships, where strictly fresh air is always at a premium.

SUBMERGIBLE ELECTRIC BILGE PUMP.

The construction and method of operation of a unique submergible bilge pump operated electrically, are shown in the accompanying pictures. The pump is used for pumping waste water out of basements where the floor level is below the sewerage system. Ordinarily the vertical motor on top of the centrifugal pump shaft is above the floor line, but in case the basement should become flooded the motor would not be injured and would work as low as 17 feet below the surface of the water.



ELECTRIC BILGE PUMP.

The pump motor and automatic parts are placed under a "protecting hood" which allows ventilation under ordinary conditions, and in case of a flooded basement the hood prevents the motor from being injured.

The protecting hood is built to utilize the principle of the compression of gases. It is hollow cylinder with the bottom end open and is set on top of the motor. The sides and top are air-tight. For water to rise inside the hood, there must be a pressure put on the water to overcome the pressure of air in the hood.

It requires one atmosphere, or a pressure equal to about 15 pounds to the square inch to compress the air in the hood sufficiently to allow the water to rise in the hood half way. This is approximately the pressure that would be encountered 34½ feet below the surface of a body of water. The motor windings being one-third of the way up in the protecting hood, for the water to rise inside even one-fourth of the way in the hood, the latter would need to be under 17 feet of water.

PUMP AND MOTOR OPERATING UNDER WATER.

The principle may be demonstrated by taking an ordinary drinking glass and a pail full of water and turning the glass up-side-down so that the opening of the glass is toward the water, and pushing the glass straight down into the water until the bottom of the pail is reached. The water has not risen to any appreciable extent in the glass, and you could burn a match or piece of paper inside of the glass until the oxygen became exhausted.

Electric sirens are in use on the railways of Germany. The sound is produced by the vibrations of a metallic diaphragm under the influence of an electromagnet.

HURRY-UP METHODS OF MILITARY SIGNALING.

In recent years the coast defenses have been materially improved and strengthened. In no particular has more progress been made than in the electrical devices by which the fire from the heavy guns is directed by the artillery officers. The days are gone by when the gunner "sighted" his gun, as a marksman aims his rifle. Now the great size and range of the guns make

USING THE FIELD BUZZER ON A RAILROAD TRACK.

it necessary that the method of sighting be scientific.

The Signal Corps, whose duty it is to furnish and maintain the electrical signaling apparatus, is now using a new portable wireless telegraph set, which makes it possible for a scouting party to keep in communication with the main body at a distance of 15 to 25 miles. The wireless set, as useful as it is, does not, as yet, displace the other methods of signaling.

The field buzzer used by the Signal Corps is a practical and efficient instrument. The apparatus is used for transmitting telegraph messages. The buzzer consists of a small vibrating armature, which operates from the power of five tiny dry batteries, making a buzzing noise of high pitch. The high frequency current developed from its induction coil to the line will find its way across "breaks" and over ground "leaks" that would put the ordinary telephone and telegraph circuits out of business. The practical use of the apparatus can be readily seen. A scout wishes to go ahead and send back his information immediately. He gets on a horse, and as fast as his horse can gallop the fine wire is laid out on the ground, and if it falls into water, or should a team pass over the wire and break the circuit, it makes little difference. When he finds out what he wishes to know, he signals his message through the wire without dismounting, as the circuit is completed through the horse's body to the ground.

It is also possible to signal with this buzzer by using a railroad track or barbed-wire fence for a conductor, as any small breaks in the circuit will be bridged across as explained above.

Captain E. H. Hotchkiss, First Company Signal Corps, C. N. G., has invent-

SIGNALING OVER A BARBED-WIRE FENCE.

ed a ground device that fastens to the heel of the shoe, thereby completing the buzzer circuit, making it possible for two men to start off in either direction and keep in touch with each other. The device was given a thorough test at Fort Wright, N. Y., last summer, and while the men climbed trees and walked on stones that were dry and well insulated, communication was maintained.

MEASURING ELECTRIC CURRENT.

BY PROF. B. A. PERKINS, A. B. (STANFORD).

CONSUMERS' METERS.

Power companies which sell electric current have adopted several methods for charging consumers for the electric energy they use. In the flat rate or contract system of charging for electric lighting, each customer pays a certain amount per month per lamp. The expense of putting in a meter and the additional expense and trouble of looking after it are thereby avoided, but as power is usually wasted when sold under this system, the power companies must charge enough to cover the *waste* as well as the *use* of the power.

The meter method of charging has proved more satisfactory, both to the company and to the consumer. But when a measurable quantity of anything is bought and sold it is but natural that the buyer as well as the seller should want to know how it is measured.

The meter for measuring currents in ampere units is called an ammeter. These ammeters (ampere meters) generally have a movable coil of insulated wire pivoted on jewel bearings and held in position between the two poles of a permanent magnet by an elastic spiral spring. When a current is sent through the coil, it becomes magnetic and reacts with the permanent magnet so as to cause it to rotate. The rotation is indicated by a pointer and is proportional to the current flowing through the coil.

From the equation, Volts = Amperes × Ohms, we see that with constant resistance, the current will vary directly as the voltage that causes it. Meters for measuring volts (voltmeters) are, consequently, constructed on the same principle as ammeters. They differ from ammeters only in having the movable coil made of fine wire having great resistance. The coil rotates in proportion to the current flowing through it, which in turn is in proportion to the electromotive force or voltage that causes it.

We notice a difference, however, in the way in which the ammeter and voltmeter are connected in the circuit. The ammeter being used to measure the volume or quantity of current passing through a circuit is so connected that the whole current passes through it. The voltmeter being used to measure the amount of electromotive force used in driving the current between two given points is connected to these two points across the circuit. A shunt or branched circuit between the two points is thus formed. The voltmeter branch having a high resistance receives only a small portion of the total current.

When we cause the ordinary direct current used in lighting circuits to flow through an ordinary 16 candle-power lamp we find the current measures ½ ampere. If we connect a voltmeter across the circuit between the point where the current enters the lamp and the point where the current emerges from the lamp, we find that an electromotive force of 110 volts has been used in driving the current through the lamp. The power, or watts, consumed by the lamp is $110 \times \frac{1}{2} = 55$ watts, from the established formula, Watts = Current × Electromotive force. When the lamp is used one hour it consumes 55 watt-hours or .055 kilowatt-hours of energy, a kilowatt being equal to 1,000 watts.

The meters that are used for measuring in terms of watt-hours or kilowatt-hours the supply of electric energy to the houses of consumers are called watt-hour meters (sometimes called recording or integrating wattmeters). It is in this type of meter, which combines the principles of both ammeter and voltmeter, that the consumer is interested.

There are several types of watt-hour meters. Most of them are small direct-connected motor-generators. Those used on direct current circuits are of the commutator type, while those on alternating currents are usually of the induction type. All of these combine three essential elements; (1) the motor element which develops driving torque or rotative effect, (2) the generator element, which develops retarding torque, and (3) the counting or recording element.

All motors and generators consist mechanically of two parts—a stationary part and a rotating part. When either machine is in operation, each of its two parts is an electromagnet. The stationary part is generally called the "field," the rotating part the "armature." In the case of motors, each wire in the armature experiences a sidewise thrust tending to move it across the magnetic lines of the field in a direction at right angles to the direction of the wire's length and also at right angles to the field's magnetic lines of force. That this thrust or force is not along the line connecting the field and the armature, but at right angles to this line, marks a striking difference between the electromagnetic force and the forces elsewhere encountered. This thrust at the surface of the armature, or "drag," as it is often called, is found to be proportional to the current in the armature and to the strength of the field. If the field has no iron in it, its strength is proportional to the current in it. The total drag on the armature multiplied by the radius of the armature gives its turning force or torque. The power of the motor is proportional to the torque and the angular speed of the armature.

The motor element of watt-hour meters used on direct-current circuits consists of a fixed magnetizing coil or field which is connected with the mains in the same manner in which an ammeter is connected and hence is often called the current coil; and a rotating coil or armature which, being connected across the mains like a voltmeter, is often called the pressure coil.

The drag on the armature is dependent on the reaction between the armature and the field and is equal to the product of the magnetic strength of each. There is no iron in the field coils of the motors used in meters so the strength of the field (magnetic flux) is directly proportional to the current. The strength of the armature's field is also proportional to the current in it, but as the armature is connected across the mains like a voltmeter, the current in it is proportional to the amount of electromotive force that has been used. We see, then, that the reaction or drag between these two coils will be proportional to the power or watts consumed. And, since with any given motor, the radius of the armature remains constant, its torque is also proportional to the power consumed.

By measuring this driving torque of the motor element of our meter, we could measure the power consumption. But it is not easy to measure the torque directly, though fortunately there is a way to get around this difficulty. The armature's angular velocity is proportional to the driving torque and inversely proportional to its retarding torque. If these two torques increase in the same ratio, then the armature's angular velocity will be proportional to the power consumed. Since it is much easier to measure and record the armature's angular velocity than it would be to measure and record the driving torque, we avail ourselves of that method.

But how can we secure a retarding torque that will always increase as the driving torque increases? That is what the generator element of our meter is for. The generator element consists of an aluminum disk carried on the same shaft with the motor armature and rotated in a field of constant value produced by permanent magnets. This disk on being rotated in the constant magnetic field has generated in it a current proportional to the speed of rotation. The current thus generated reacts with the field of the permanent magnets producing a retarding torque proportional to the velocity. With this ingenious retarding arrangement added to the motor element of our meter, we can measure the armature's angular velocity rather than its torque, since both are now proportional to the power consumed.

All that is now necessary to add to the measuring device in order that it may measure the energy supplied to our circuit is a mechanism to record the total number of the armature's rotations since each rotation represents a certain amount of energy. This mechanism consists of a train of gear wheels connected to the armature's shaft. The wheels operate pointers on the dials. Thus with the motor element, the generator element and the recording element, the watt-hour meter is complete.

In Fig. 1 is shown the armature (spherical portion) of the motor ele-

ment, the armature shaft, and on the lower end of the latter the generator disk. Fig. 2 shows the gear wheel mechanism driven by the rotating elements of the meter and which move the little pointers around on the dials to indicate the number of watt-hours. Fig. 3 shows the watt-hour meter complete with front cover removed. At the bottom is seen the generator disk revolving in the field of the permanent magnet. In the cen-

FIG. 1. ARMATURE AND GENERATOR DISK OF A WATTMETER.

ter, partly concealed, is the revolving armature, the shaft of which drives the gears for the little pointers of the dials at the top.

The induction type of watt-hour meter which is generally used on alternating current circuits consists, like the commu-

FIG. 2. GEAR WHEEL MECHANISM.

tator type just described, of three elements—a motor element, a generator element and a recording element. The only point of difference between the two meters is in regard to the motor element. In the induction type the field is made up of two coils; one connected in series with the circuit, the other as a shunt or branch between the point where the current begins its work for us and the point where it has finished its work for us. The combined field strength is consequently equal to the current times volts, or the watts that are consumed on our load.

The armature consists of an aluminum disk similar to the generator armature and rotated on the same shaft. As in the commutator meter, the driving force on the motor's armature and the retarding torque in the generator's armature increase in the same ratio, both being proportional to the amount of power consumed on the load. It remains, then, as in the first case, merely to record the armature's rotations by means of a train of gear wheels operating pointers on a dial.

Watt-hour meters of modern make are very accurate instruments. To secure

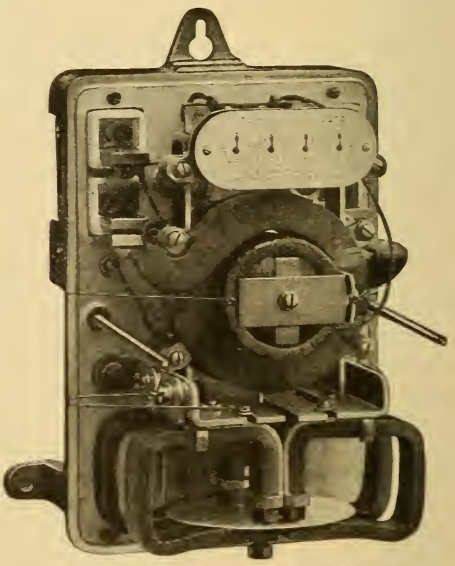


FIG. 3. WATTMETER ASSEMBLED.

greater accuracy the revolving shaft is mounted on jewel bearings. The Westinghouse service meters bear this statement of their accuracy: "This meter registers directly in kilowatt-hours. It has been compared with a standard meter in the factory of this company and registers within two per cent plus or minus from two per cent of full load to 50 per cent overload, which overload it will carry continuously."

All meters, however, should be tested once or twice a year. The best way to test meters on the premises is to connect an accurately calibrated watt-hour meter in series with the house meter and thus compare the readings of the two. A rough method of testing which may be employed by the customer is to use a given number of incandescent lamps for a given time and compare the calculated energy required with that registered by the meter. Since each 16 candle-power lamp consumes about 55 watts, the calculated energy consumption would be:

Number of lamps $\times$ 55 $\times$ hours burned = watt-hours.

We must now learn to read the number of watt-hours registered on the meter dials. This is very much like learning to read time on a watch. The watch has but one dial though it has two pointers, one of them being geared to rotate 1/12 as fast as the other. Since meters deal with larger numbers than a watch, they need more pointers. To place four or five pointers on a single dial would make the reading needlessly confusing, hence a separate dial is provided for each pointer. The pointers are geared to rotate in a ratio of tenths—that is, each successive pointer (going from right to left) rotates 1/10 as fast as the preceding one.

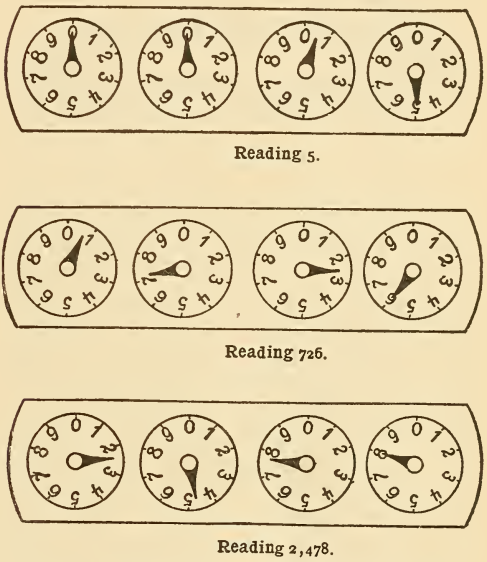
In the upper row of dials in Fig. 4 the pointer on the first dial at the right has made half a rotation and moved through five spaces, each dial being divided into 10 spaces.

The pointer on the second dial moving 1/10 as fast, has moved through ½ space; the third pointer has moved 1/10 of ½ = 1/20 space; while the fourth pointer has moved 1/10 of 1/20 = 1/200 of a space.

When the first pointer has moved through 10 spaces (indicating the consumption of 10 watt-hours) it is again at 0, so that one could not see that it had moved at all, but the pointer on the second or ten's dial is now pointing to 1. So also when the pointer on the first dial has made 10 complete rotations (passed over 100 spaces) the pointer on the second dial has made one complete rotation and both are at zero, but the pointer on the third or hundred's dial is pointing at 1, thus indicating the consumption of 100 watt-hours of electric current.

Generally the pointers will not be pointing directly at a figure, but somewhere between two. It is always the figure which the pointer has left and not the figure which it is approaching that is to be taken.

The second row of dials in Fig. 4 gives a reading of 0726, thus indicating



Reading 5.

Reading 726.

Reading 2,478.

FIG. 4. HOW TO READ THE METER.

the consumption of 726 watt-hours, while the third row gives a reading of 2478, indicating a consumption of 2,478 watt-hours or 2.478 kilowatt-hours. Some meters have the dials calibrated to read directly in kilowatt-hours. In some ways this is more convenient because most of the bills are made out in kilowatt-hours.

As a rule the bills are rendered monthly, but the meters are not turned back to zero at the beginning of each month. The amount consumed in one month is obtained by subtracting the previous month's reading from the present month's reading.

When you receive your next bill for electric power you may have at least the satisfaction of checking it with your meter's reading before paying out your money for it.

HATCHING CHICKENS BY ELECTRICITY.

Nature has a way of doing things in such an apparently simple manner that men are inclined to think they can easily accomplish the same results by artificial means and encounter no great difficulty. It appeared to be so easy for the old hen to sit three weeks on a dozen eggs and hatch a brood of chickens that some

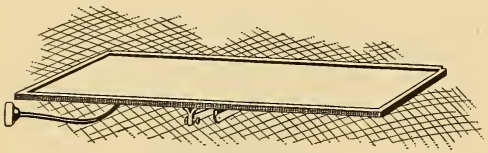


FIG. 1. THE "ELECTROPLANE."

one evolved the idea of making an incubator which would do the work of a dozen hens. It was then found that the main object in the life of a hen was not such a simple matter after all. Among other things, there could be very little variation from "hen temperature" or there would be trouble. This temperature of 103 degrees, Fahrenheit, must be maintained during the whole period of incubation, with the exception that for short periods, corresponding to the time that a hen is off the nest, it may drop a few degrees. So, after all, it was no simple matter to devise a satisfactory incubator.

To keep the temperature constant with the old-style incubator is a problem, and added to that there is the odor from the oil lamps, the frequent attention, refilling of lamps, etc. Naturally, therefore, the question arose, How can we make an electric incubator which will keep an even temperature and require no attention? After much experimental work the problem was solved, and a complete electrical equipment designed, not only for hatching the chickens, but for brooding them until they are old and strong enough to care for themselves.

First in this unique chickens hatching system comes the "Electroplane," which is the trade name for an asbestos, metal-bound electrically heated and regulated diaphragm, designed for use in the upper part of the egg chamber. A sketch of this electroplane is shown in Fig. 1. Underneath the asbestos plane is a heating coil, through which current from the ordinary lighting circuit is passed. The resistance of this coil of German silver wire to the passage of the current causes heat to be generated, which is transmitted to the asbestos plane, giving a uniform distribution of heat at all points above the eggs.

To keep the temperature constant a "thermostat" is included in the circuit. This thermostat is made of two metals of different expansive properties when under the influence of heat. These metals are fastened rigidly together, so that when they are heated one expands more than the other, and the solid strip begins to curve into a bow shape. When the temperature reaches a certain point the metal strip bends sufficiently to separate two contacts in the circuit and shut off the current. Then, the current

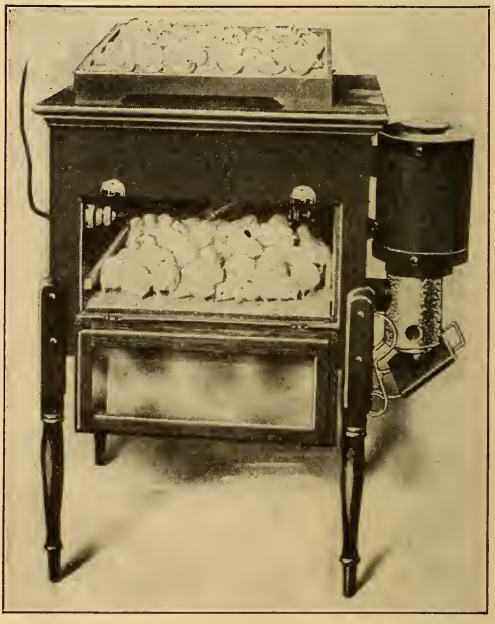


FIG. 2. THE "ELECTROBATOR."

being shut off, the temperature gradually falls and the strip of metal straightens out till the contacts touch again and current once more flows. This process goes on constantly, but so delicate is the apparatus that the temperature varies but a part of a degree.

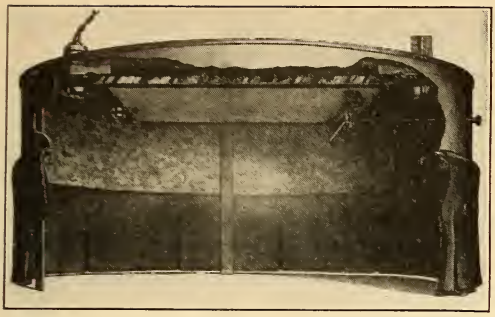


FIG. 3. ADAPTABLE ELECTRIC HOVER.

The Electroplane is so constructed that it can be placed in an ordinary lamp-heated incubator and electrical operation secured with very little trouble. Or it may be used in a special incubator known as the "Electrobator," shown in Fig. 2. Almost no attention is required, and the temperature remains practically constant day and night.

After the chickens are hatched it is

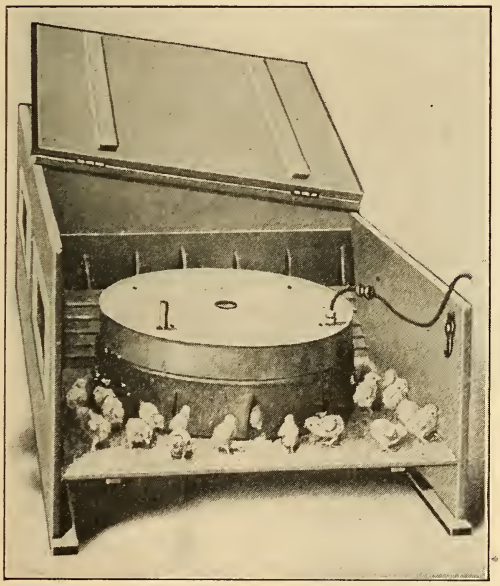


FIG. 4. ELECTRIC HOVER AND ENCLOSURE.

necessary to use an artificially heated brooder or hover. This is provided for by the adaptable electric hover shown in Fig. 3. In the illustration one side is cut away to show the interior. It consists of a circular, asbestos-lined casing, which stands on four legs, the open part at the bottom being covered with a curtain, so that the chicks may run out and in. In the upper part is hung one of the Electroplanes, as described above, with temperature regulating thermostat. Another view of the hover is shown in Fig. 4, where it stands in an enclosure in which the chicks may exercise.

HARNESSING THE HEAT OF ELECTRICITY

It is an impatient, speed-mad age, and electricity, quicker even than light, is the one agent to faithfully keep the pace a hustling people has set. This insatiable demand for speed has done more to further the wonderful development of electricity in the past few years than any one thing. In this "press-the-button" age both necessities and luxuries are demanded at the touch of a finger.

The mails are too slow, and electricity must carry the messages through the air over the seven seas!

Steam power is too cumbersome, and electricity must bear the burdens!

Oil and gas are too inconvenient, and electricity must give light!

Last of all, coal has been pronounced archaic and electricity must give heat!

There is no time to waste over slow fires. The demand is for instantaneous heat and plenty of it. Electricity, which has answered all the problems of speed, has been called upon and the result is a long list of electric radiators and electric heating and cooking devices.

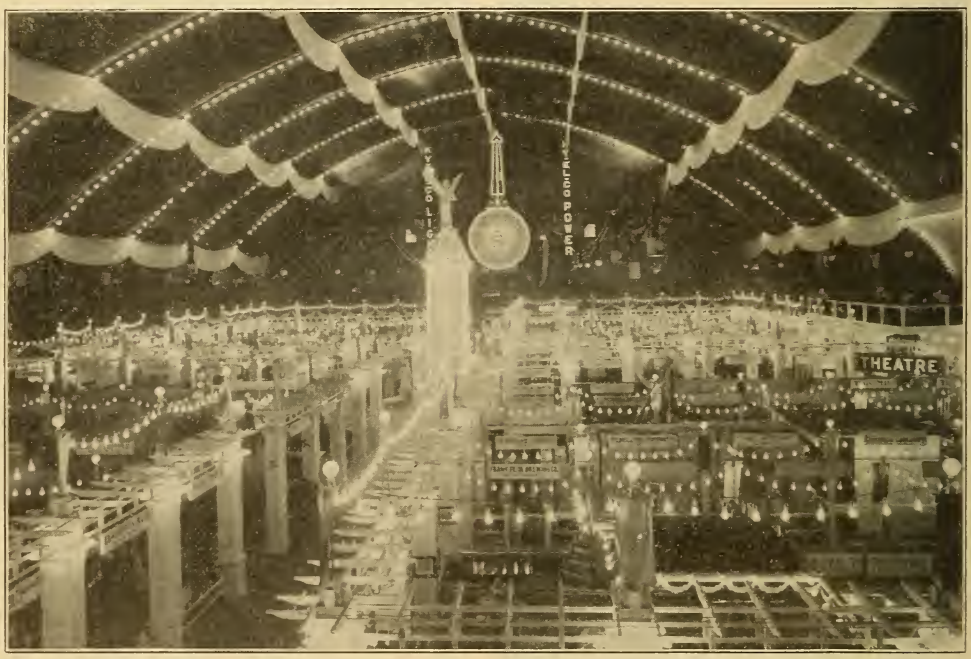
No more mysterious source of heat can be imagined than that afforded by electricity. Without flame, smoke or gases it is ready in an instant and can be regulated at will from a slight warmth to the carbon-melting temperatures of the electric arc furnace.

Evidence that electricity as a source of heat is taking a very important place in this impatient world is that the Eagle Hotel, in Grand Rapids, Mich., has been equipped with luminous electric radiators.

A St. Louis druggist prevents selfish customers from monopolizing the free telephone by installing a switch in the telephone wire, and placed behind the prescription counter. This can be opened so as to prevent the use of the telephone by the "long-winded" offender.

SIGHTS OF THE LOUISVILLE ELECTRICAL SHOW.

The city of Louisville and her business institutions have made a remarkable demonstration of the advancement which has been made in the application of electricity. The Southern Electrical and Industrial Exposition which was held April 12th to 24th was the first big electrical show to be held in a southern city, and it is expected that the results of the demonstration will be far-reaching in their effect upon the electrical development of the South. To enter the great armory, canopied with color and shimmering with the gleams of thousands of electric lights was to see what a modern city may be made at night.



THE SOUTHERN ELECTRICAL AND INDUSTRIAL EXPOSITION AT LOUISVILLE.

Numerous exhibitors, representing various kinds of electrical devices, occupied the gaily decorated booths. A center tower, forty feet high, symbolized the Godess Electra, and she held aloft an electric lamp, which gleamed into the lofty ceiling of the great building, entirely roofed over with tightly drawn green cloth, out of which sparkled hundreds of lights in well ordered rows. On the south wall of the armory was an electrical clock one hundred feet high. On the north wall of the building was probably the largest oil painting ever hung, being a panoramic view of New Albany and Jeffersonville, Louisville's two largest suburbs.

The spectacular feature of the show was the electric clock above mentioned and which is shown in the frontispiece of this issue. It is the invention of H. C. Korfhage, a jeweler of Louisville. The proportions of the clock were truly amazing to the spectator. It was 48 feet in length. 23¼ feet in width and weighed over 3,000 pounds. It contained 5,500 multi-colored bulbs, for which 11,000 connections were necessary.

The number of lights used on this single clock, when analyzed, brings forth more startling comparisons. They number more than the entire amount of incandescent globes used to illuminate the cars of the whole street car system of the city of Louisville and would light brilliantly 275 residences or stores, allowing 20 lights to each.

The dial of the clock is 20 feet in di-

ameter and differs widely from the ordinary clock dial, in that although it indicates hours, minutes and seconds, it has no hands. The time by minutes is indicated by 60 series of lights, each containing 32 electric globes and radiating from an ornamental centerpiece to the outer edge of the dial. One series remains lighted for one minute and shows the position of the minute hand as indicated in the picture. Shorter rows of different colored lights indicate the hour hand, and these light up at five different points during the hour. The seconds are shown by 60 lights placed at equal distance around the extreme outer edge of the face. The hour figures are about three feet high and are outlined in colored globes. Each second the illumination in the outer circle of lights moves forward one, and when the entire clock has been encircled the lights indicating the minutes also advance; and the hour hand makes its slow journey at twelve-minute intervals.

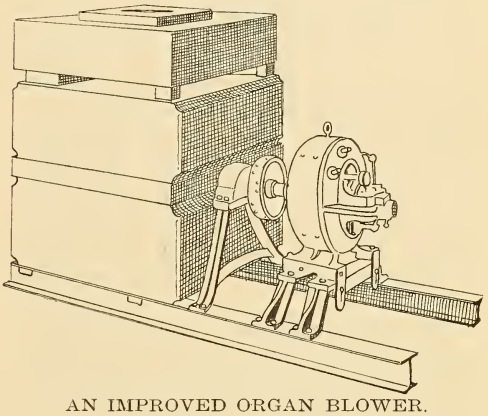
Despite the huge proportions of the clock it will keep absolutely correct time even to the second, and this is the first time that such minute accuracy has been attempted in so large a clock. The motive power for the pendulum movement is supplied by a small magnet at the side and near the top of the pendulum, but this is not visible from the floor, and the impression produced is that the pendulum is operated by its own momentum.

AN IMPROVED ORGAN BLOWER.

One of the interesting applications of electric motors is the use of this power for church, concert and house organ blowing. It has long been recognized by organists and builders that for organ blowing a centrifugal fan is far superior to feeders operated by any other method, because of the absolutely steady pressure developed, which greatly enhances the quality and purity of tone of old and modern organs.

Until recent years this type of machine could not be used because of the excessive noise of the ordinary trade fan blower, which formerly was the only machine of this character on the market.

The Kinetic blower has been designed expressly for organ blowing, and has effectually overcome this difficulty. The machine consists of several fans mounted on one shaft, by the rotation of which the required air pressure is generated, each fan adding the pressure developed by itself to that of the preceding fan.

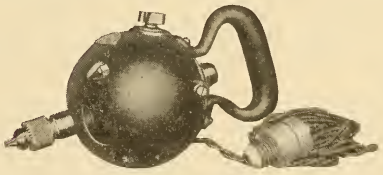


AN IMPROVED ORGAN BLOWER.

These fans are enclosed in a case and the whole mounted on an I-beam base and direct connected or belted to an electric motor; motors in all cases being unenclosed. It can be run equally well by either direct or alternating current motors. No care is required by either blower or motor other than filling the oil cups every few weeks.

MOTOR OPERATED HAND DRILL.

Many a laborious drilling operation may be performed with comparative ease by the motor operated hand drill which can moreover be used in more inaccessible places than the ordinary



MOTOR HAND DRILL.

breast drill. The motor is inclosed in a spherical casing provided with a handle. The drill holder is mounted on the end of the motor shaft and a flexible cord and plug for attachment to a lamp socket completes the apparatus.

HOW TO DO ELECTROPLATING.

BY J. R. WILSON.

PART I.

Electroplating is the process by which a metal or alloy (mixture of two or more metals) held in solution by a liquid is deposited electrically on a prepared surface. From the solution the metal is thrown on to the object receiving the deposit and at the same time an equal quantity is dissolved from metal plates (called anodes) suspended in the solution. Hence, although the solution is constantly robbed of metal, it is fed by the anodes, which must always be of similar metal to that held in solution, so that the strength of the solution is maintained.

The first consideration in installing an electroplating outfit is the selection of a light and well ventilated room and if possible the separation of the room into two sections—one for the polishing work and one for the plating work. This should be done because the dust and lint from the polishing operation is liable to ruin the plating solutions which must be kept clean. If it is not practical to separate the rooms a little care in keeping the solutions well covered when not in use will be satisfactory.

PREPARATION OF THE "WORK."

Before an article can be plated it must be perfectly clean and smooth. This means that the surface as well as being free from scratches must be free from grease or grime, otherwise the plate will not adhere. This is an essential point to bear in mind. Do not become too enthusiastic to see the work finished, for here is where the plater will fail more often than at any other stage of the work.

Assume, now, that the object to be plated, which is termed "work," is a rough iron or steel casting. Its surface is full of sand and scale which can be removed only by immersing in an acid solution. This is called "pickling," and to do it, secure an earthenware jar (it will be necessary to have several of these for different solutions) large enough to hold the largest piece of work that will require plating. Label this jar "acid dip" and make up the following solution:

Sulphuric acid (oil of vitriol) . . . 1 part
Water . . . . . 4 parts

In all the operations it is necessary to use good, clean, soft water (rain water is the best); hard water makes all the solutions difficult to handle. To mix the above, place the water in the jar and pour the acid in gently, stirring the mixture constantly. Remember never to pour water into the acid as violent heating takes place and possible spattering of the acid.

Immerse the work in the acid solution, suspending it by wire from the edge of the jar. This may require 30 to 90 minutes. Remove from time to time and if the scale and sand loosens readily when brushed with a stiff wire brush and wet pumice it has been pickled sufficiently. If it does not come off readily reimmerse. This must not be overdone, however, as the casting itself will be attacked by the acid and a porous surface result which it is useless to attempt to plate and might as well be thrown away.

Having removed the crust and sand as directed above, the work is ready to be polished.

All castings of whatever metal require pickling before polishing. If the work is a machined piece of course this is neglected. If the casting is copper, brass or bronze, then it is best to pickle the casting in dilute muriatic acid (muriatic acid, 1 part; water, 15 parts), next remove the scale and then clean and brighten it by dipping in the following solution:

Sulphuric acid . . . . . 50 parts
Nitric acid . . . . . 100 parts
Common salt . . . . . 1 part
Lampblack . . . . . 1 part

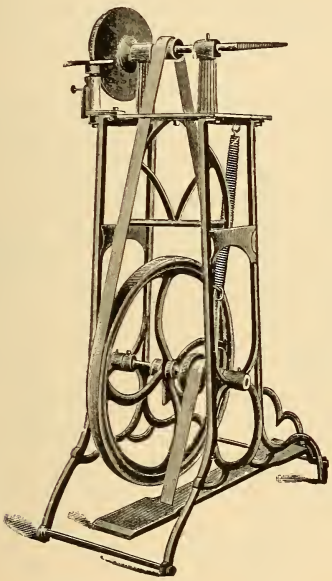
Mixed in the order named.

Rinse well in hot water and it is ready for the polishing wheel.

A polishing outfit consists of a lathe, which should revolve at a speed of 2,500 to 2,800 revolutions per minute, polishing wheels of various sizes and materials, emery, glue and a water jacketed glue pot.

The most preferable lathe is that operated by power by means of belting from countershafting or by direct connected electric motor. If neither electric or steam power is available, a good foot-power lathe of the latest type gives very satisfactory results. Having secured a lathe, fasten it firmly to the floor or bench, as very much vibration retards good work.

Polishing wheels are made up of numerous layers of canvas glued or cemented together; or may be of felt or of wood, the latter being faced with leather. The selection is a matter of preference. If the work is a flat piece with edges that must be sharp and square the last named is preferable.



FOOT POWER POLISHING LATHE.

The wheels before they can be used must be faced with emery. As each work must be gone over on three or four different grades of emery, it will be necessary to have the following grades, each kept in its own long shallow box and labeled: No. 60, 80, 100, 120, 140, 180.

Prepare a good running glue—the best glue must be procured as ordinary glue will not hold the emery—and apply it to the face of the wheel with a brush. To do this conveniently, place a snug fitting mandrel (a rod or stick) through the center hole of the wheel and rest the projecting ends on two parallel supports so that the wheel will be free to turn. Roll the wheel in No. 60 emery until it presents a well covered surface and set aside to dry. Repeat the operation with each wheel using a different grade of emery for each. Do not allow the different grades of powdered emery to become mixed. Label each box plainly.

The first step in the polishing process is called "roughing out." If the work is iron or steel use a No. 60 emery; if brass or any other soft metal use No. 80 or No. 100. Place the wheel on the spindle of the lathe and start up the power, always having the wheel turn towards the operator. If the wheel is not properly balanced it will wabble or pound. In this case shut off the power, remove the wheel and using a mandrel as directed for gluing, rest the wheel on two parallel and horizontal knife edges. The wheel will turn until the heaviest side is downward. Tack or screw a small piece of lead on the wheel directly opposite the part that points downward. Continue this till the wheel is balanced.

Hold the work at about the middle of the lower front quarter of the wheel. It should be held firmly in the hands, using a gentle and uniform pressure, and when applying or removing the work do so abruptly and firmly; otherwise the work may be thrown from the hands. The work must be kept "alive" on the wheel; that is, not allowed to stop at one place or excessive grinding will result. This must be remembered especially when buffing after plating.

Taking, for example, No. 60 wheel for the roughing out, when the surface has been gone all over and nothing but No. 60 marks show, use the next finer wheel (in this case No. 80) and repeat the process until only No. 80 marks show. Then use the next finer wheel and before applying the work apply a little tallow or oil to the revolving wheel with a cloth swab. This is called the grease wheel. Before this wheel can be used again on other work the grease must be removed by applying a piece of lump pumice to the revolving wheel. It is best to use a wheel for this step that has been worn smooth.

For softer metals than iron or steel it is best to use the finer grades of emery. Remember that no scratches must show. The surface must be perfectly smooth as plating covers up nothing in the way of defects; in fact it makes them more prominent.

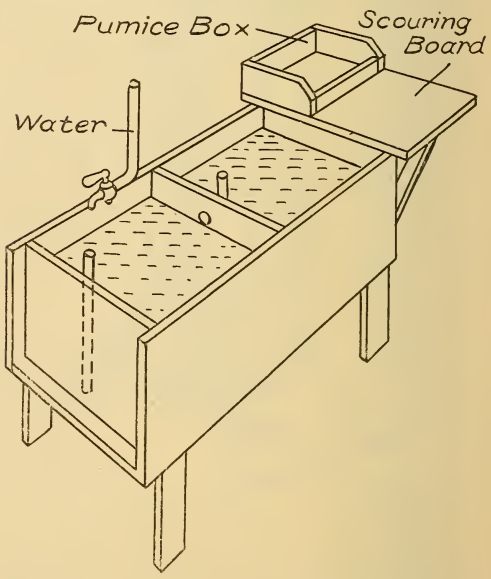
To get the brightest polish or surface on metal some prefer to further polish the work on a felt or cotton flannel wheel (the latter is made of several sections of cloth each section containing several layers sewed together) using a polishing composition such as tripoli or rouge. This is not essential, however. For the amateur it is best to buy the cloth wheels outright than to try to make them.

For those who cannot afford to provide a polishing lathe the work can be done by hand just as well as it was in the days before power was used. For the removal of scratches, etc., provide lumps of pumice and face them up by rubbing on a flat stone. With these lumps dipped in water go all over the scratched surfaces thoroughly until all scratches are obliterated. Then go over all the work until the surface is uniform. Rinse and dry the work. Then go over it again using emery cloth; this rubs out scratches made by the pumice. Scour off all traces of emery with a soft hair brush and water, rinse well and go over the surface again using rotten stone to rub out the emery marks. The stone must be dipped frequently in water. When the surface appears quite smooth, finish with a piece of buff leather smeared with fine cut crocus, tripoli, or rotten stone and oil.

Polishing wheels six to eight inches in diameter and one to 2½ inches thick are best to use instead of the larger wheels, especially with a foot power lathe or a very small bench lathe.

The work now presents a magnificent surface but it would be a grave mistake to attempt to plate it yet. The surface during the above operations has become smeared with grease and oil that is almost imperceptible. Even the slight amount of oil coming from the hands will cause the plating to peel off.

To make the surface chemically as well as mechanically clean is the next essential step. To do this provide an old iron kettle or water jacket of a glue pot and a gas stove or plate. Make up a hot caustic potash solution by dissolving one-half to one pound of potash (lye) to each gallon of water used. Maintain this at boiling temperature and having fastened a sling wire to the work (this is done by twisting a piece of wire to the work and bending into shape of a hook) suspend the work in the solution from the edge of the tank. This will effectually remove the grease or oil. When the work has been in this solution 10 to 15 minutes remove, rinse in clean water and then scour it with pumice



SCRUBBING AND RINSING TANK.

stone using a stiff bristle brush. If the metal is brass or any other soft metal, Vienna lime or whiting is sometimes preferred to pumice, as it is not so liable to scratch. Rinse well in water and if the latter runs evenly over the surface (that is, does not separate) the surface is clean. Be sure this is the case.

Now dip the work, if it is iron or steel, for a moment in an acid solution composed of one part muriatic acid to eight parts of water, rinse again in clear water to remove all traces of acid and transfer the work without delay to the plating vat. If the work is any other metal than iron or steel then in place of the acid dip a cyanide dip is used. This is pre-

pared by dissolving one-half pound of chemically pure cyanide of potash to a gallon of water, and used cold. Keep this in a glazed earthenware jar (the same as those for the various acids) and label it "cyanide dip." Keep all dips and pickles covered when not in use.

For the scrubbing and various rinsing operations it is essential to have plenty of good, clean, running water. Some convenient arrangement must be devised. As a suggestion, provide a wooden vat and separate it in two divisions as shown in the cut by placing a partition across the center. Have a faucet over one division and water running into it constantly. Near the top of the partition a hole should be bored and the water from the above division will flow into the second division. The waste pipe in the latter must have a standing overflow extending not quite to the level of the hole in the partition. Nail a board across the end of the tank farthest from the first division. This will serve for the scouring board and also on which to keep a box of pumice or whiting. After scrubbing the work on the board it is then dipped in the overflow water (second division) and then rerinsed in the other division, in clean water. This clean water will also answer for the various other rinsings mentioned.

(To be concluded.)

EXPLAINING THE "SHORT CIRCUIT."

In this electrical day one hears and reads a great deal about "short circuits" without having the slightest idea of what the expression means.

The "short circuit" means simply that wires have become crossed or connected so as to form a by-path or shunt of comparatively low resistance through which so much of the electrical current passes as practically to cut out that part of the circuit through which the current originally flowed. In other words a "short circuit" has replaced the normal circuit which may be considered as a "long circuit." The cutting out of the resistance of the long line permits the power to rush over this path of low resistance and if the apparatus was not protected by the circuit-breaker, the electrical machinery would do itself serious harm.

To prevent serious effects from accidental short-circuits of electric lighting wires in buildings a "fuse" is inserted in the circuit just inside the building. In case a nail or some other falling object short-circuits the electric wires in the house this "fuse" blows out; i. e., melts out, and throws the circuit open so no electricity can flow through the wires in the house until the "short" is found and corrected.

TELEPHONY IN THE SILESIAN ALPS.

The mountains of Silesia are noted for their heavy frosts and sleet storms. Trees, rocks, telephone and telegraph poles, and even houses, are enveloped in a thick coat of ice and snow, so distorted and grotesque as to leave their true form scarcely recognizable. The illustration presented here gives a good idea of the

ICE FORMATION IN THE SILESIAN ALPS.

appearance of the telephone poles at such a time. The telephone lines and systems in Silesia are owned by the government, which removes the wires from their overburdened poles during the winter and stores them out of harm's way until spring.—Telephone Engineer.

DISTRIBUTION OF ELECTRIC CURRENTS.

BY JACOB GLOGAU.

The two common systems of electric distribution are known as (1) the constant current and (2) constant potential. In the constant current system, as the name implies, the current is constant and as the resistance is variable the voltage rises and falls. In a constant potential system the voltage remains constant and as the resistance varies the current rises and falls.

The Constant Potential System.—This system is used for interior work because there is not much danger on account of the low voltage used for this system. The voltage generally used is 110, 220, and no higher than 550 volts, and in the regular work 110 volts is the standard.

The size of the conductor used is determined by the amount of current it can carry without over-heating, and secondly the drop in potential allowable for economic lighting. The second condition is the most important as the first condition is reached after the second one has been determined.

Following is a table showing the safe carrying capacity of interior wires:

Size of wire. No.	Circular Mils.	Current in amperes. Rubber Ins.
14	4.107	12
12	6.530	17
10	10.380	24
8	16.510	33
6	26.250	46
5	33.100	54
4	41.740	65
3	52.630	76
2	66.370	90
1	83.690	107
0	105.500	127
00	133.100	150
000	167.800	177

When laying out the design for the distributing system care should be taken to obtain a symmetrical system. If this is not followed out some illumination will be lost, the lamps will not receive the right amount of power and will burn dim.

One of the most used systems is that known as the three-wire system. There are a great many advantages in this system, among them the saving of copper wire, which forms the greatest item in all kinds of electrical work. The higher the voltage transmitted the less copper is used to transmit it, thus a 110-volt lamp requires one-half of an ampere, but if we were to use a 220-volt lamp then the lamp would only consume one-fourth of an ampere, thus reducing the size of the wire to one-half the size, thus it follows that there is a great saving of copper.

In the three-wire system the lamps are arranged so that two 110 volt lamps, requiring twice the voltage but equal the current of one lamp, are practically connected in series across the two outside wires. Fig. 1 shows an ordinary three-wire system.

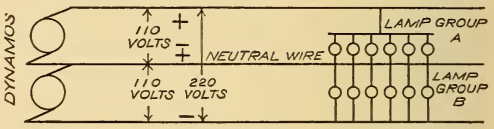


FIG. 1. THE ORDINARY THREE-WIRE SYSTEM.

The middle wire is called the neutral wire, the outer wires being generally made about one-half the size that would be required for the same number of lamps burning on a two-wire system. Theoretically the neutral wire may be one-half the size of the outside wires, but in practice the three wires are generally of the same size, so as to permit one-half of the lights on if the other half is not burning. Looking at the diagram, suppose all of the lamps to be turned on. Current will flow from the positive side of the circuit through the two groups of 110-volt lamps in series to the negative side of the circuit. None will therefore flow back through the neutral wire to the dynamos, and the circuit is said to be balanced. Suppose, however, one of the lamps, as in group (B), is turned out. There is then more current flowing through the lamps of group (A) than can pass through the lamps (B) to the negative side, so the surplus current (equal to the current of one lamp) flows back to the dynamos through the neutral wire. Turning out more lights in group (B) correspondingly increases the current on the neutral. In this manner we are able to burn the ordinary 110-volt

lamps on what virtually amounts to a 220-volt circuit with a consequent saving of copper as explained above.

The foregoing is the principle upon which the three-wire system operates, although there may be used what is known as a "compensated" generator; one machine, to take the place of the two dynamos.

The Constant Current System. This system is used for outside work only owing to the high voltage used, the voltage being from 550 to perhaps 3,000 for arc lighting. The lamps used in this system of lighting are connected in series. Fig. 2 shows a series circuit (constant current) for 550 volts with five 110-volt lamps in series.

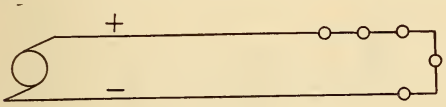


FIG. 2. A SERIES CIRCUIT.

In this system the capacity of the wires in the circuit is equal to the current necessary to feed one lamp as all the lamps in the series circuit require the same amount of current, thus in a 550-volt circuit there are five 110-volt lamps, the combined amperage being one-half ampere.

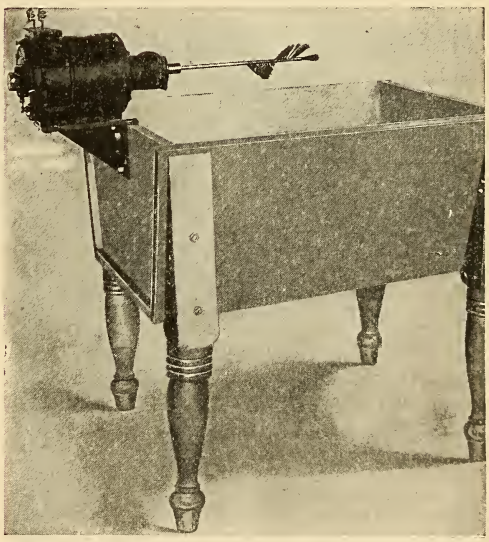
The system is very simple, but there are a great many objections which have to be overcome, first, as each lamp takes the same current, as the number of lamps increases the voltage also must be increased and then if one lamp is extinguished the whole circuit becomes dead and all the lights go out. In the arc lighting system there may be 50 lamps on the circuit, the current used being about ten amperes and the voltage about 2,500.

When series lamps are used they must be equipped with an automatic cut-out so that if for some reason one lamp breaks the circuit will not be disturbed. The circuit of the lamp is therefore divided into two parts, one path going through the filament of the lamp and the other path going to the two terminals; between these terminals there is a piece of paper. If the lamp breaks the voltage due to the electromotive force of the system will pierce the paper and the two terminals will make contact, thereby re-establishing the circuit. In trolley cars the voltage used is 550 volts, thus requiring the connecting of five lamps in series, the only objection being as stated before that if one lamp goes out the other four will also go out.

NOVEL BOTTLE WASHER.

Small dairies, carbonating and bottling establishments usually have a considerable number of bottles to clean, although probably not enough to warrant the installation of an expensive automatic bottle washer. To meet this need a small motor driven bottle washer has been developed. It consists of a 1/5 horsepower motor with cast iron bracket for attaching to a tub or sink. A specially designed shaft receives the brush spindle, the end of the motor toward the brush being provided with a special housing to protect it from moisture.

In operation the tub or sink is partially filled with water and the bottles to be



ELECTRIC BOTTLE WASHER.

cleaned are immersed within convenient reach of the operator. The rapidly revolving brush is inserted in the mouth of each bottle in turn, leaving the bottle partially or entirely filled with water during the process. If the bottle is held firmly and a slight pressure exerted to

force the bottom against the brush, entirely satisfactory results may be obtained.

Inner globes of enclosed arc lamps may be easily and thoroughly cleaned by this device and central stations operating 50 or more lamps will find that the resultant saving of time and labor will in a short period repay the small amount invested in one of these outfits.

TUNGSTEN LAMPS FOR STREET LIGHTING

High efficiency of the new tungsten lamp has made the incandescent lamp a serious competitor in the field of street lighting. Of late years we have seen the incandescent lamp used for this purpose only in very small towns, and even there the indifferent results secured with the old style carbon filament lamp were rapidly leading to its disuse in favor of arcs. With the tungsten, however, about three times the light can be obtained from the same amount of current, so an old field of usefulness is being revived for the incandescent lamp.

STREET LIGHTING WITH TUNGSTENS.

The tungsten lamp for street lighting is burned on what is known as the series system, which requires only one wire. A special apparatus has also been devised to keep the current constant so as not to burn out the delicate filaments. Sometimes the lamps are burned in clusters, sometimes singly. This enables the lighting to be adjusted to the requirements of different localities. The system has even been so far developed as to enable the tungstens to be burned in conjunction with series arc lamps, using one circuit for the two, so an arc lamp may be burned in one spot, where a very strong light is desired, and farther on in the same circuit, a tungsten may be connected, where less brilliancy is needed.

TUNGSTEN STREET LAMP AND REFLECTOR.

One of the pictures shows a street in an outlying and rather select district, which is lighted with a line of tungstens. With neat poles and ornamental brackets they do not detract from the beauty of the surroundings. The second illustration is a near view of one of the lamps, provided with radial wave reflector and also with means for raising and lowering the lamp where center span suspension is used, as in the case of the ordinary arc lamp.

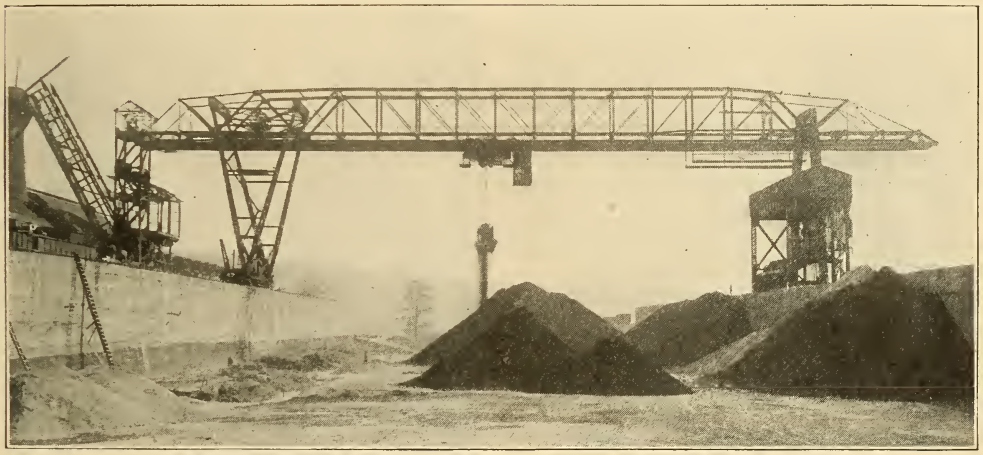
HANDLING 600 TONS OF ORE IN AN HOUR.

Six hundred tons of iron ore handled in an hour, and by one man. It is almost unbelievable. Yet it is accomplished daily at the great sheet and tube plant in Youngstown, Ohio, and is but another example of the part electricity plays in industrial works.

A steel bridge hundreds of feet long spans the ore yard and serves six blast furnaces. Adjacent to the furnaces are storage bins under which the larry cars operate to conduct the ore from the bins to the furnace skips. One supporting leg of the bridge rests on this bin structure, and the other is carried by a concrete wall 26 feet high.

The bridge with its cantilever extensions is approximately 460 feet long. The iron ore is brought within reach of the bridge by transfer cars, which operate between the car dumper a thousand feet or more from the ore yard and run on tracks carried by the bin structure. These transfer cars discharge their load through an open track onto baffle plates, which form a temporary pile along the bin side of the storage yard. By means of the grab bucket the bridge gathers up the ore and places it in storage or removes it from the storage pile and delivers to transfer cars for distribution into various compartments of the bins, from which the supply for the blast furnaces is drawn as needed.

The bridge travels along the tracks propelled by two 52-horsepower motors. The bucket car travels back and forth from one end of the bridge to the other; also operated by a motor. The grab bucket is raised and lowered by motors, and with its mouthful of ore weighs 50,000 pounds. All these operations are controlled to a nicety by the man in the traveling cage.



MOTOR OPERATED TRAVELING BRIDGE FOR HANDLING ORE.

PRODUCTION OF NITROGEN FERTILIZER.

It has been calculated that the amount of fertilizer in the form of natural nitrates still available is less than that required for the world's supply for the next 20 years—that is, assuming that no new sources shall be discovered. It is this fact which has brought into such prominence the necessity of obtaining a fresh supply of nitrogen compounds, and has consequently led to the erection of large plants for fixing the nitrogen of the air.

In spite of the many attempts which have been made to fix atmospheric nitrogen, little pioneer work in the way of research has been done to assist the inventor to obtain the best yield from any form of apparatus.

As pointed out in a paper read before the Institution of Electrical Engineers in London, by Cramp and Hoyle, most inventors have attempted to fix the nitrogen of the air by the use of very high temperatures—that is, by really attempting to burn the nitrogen in the presence of oxygen to NO and NO_2, usually by means of the electric arc. In

some cases, instead of burning the gases direct, union has been obtained by means of a third substance, such as calcium carbide.

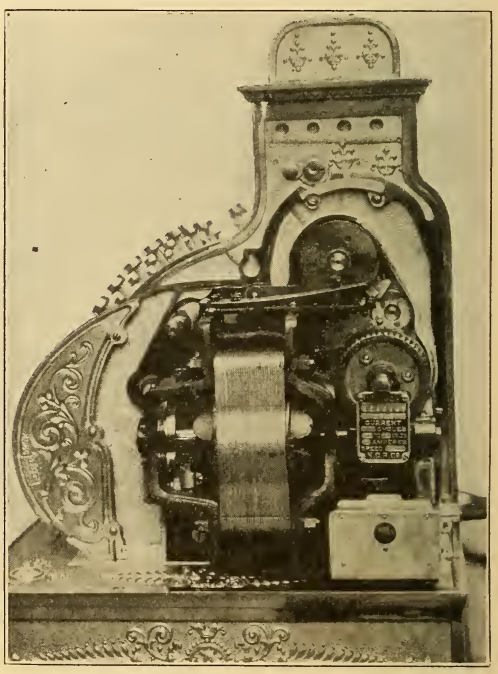
Each succeeding designer has decided upon some point in the form of the discharge to be used, which he believed to be the most important factor in determining the production of the gas. Thus one believes that it is most essential to get the current of air into very intimate relationship with the flame (Naville and Guye). Another considers that the essential condition is to have no continuous flame, but a very large number of arcs (Kowalski and Moscicki). A third thinks that not only is a large number of arcs necessary, but that these should be also very long and very thin (Bradley and Lovejoy). Others attempt to combine these results with effects of very high temperature of the gas followed by very sudden cooling; and, again, some believe in the effectiveness of temperature gradient alone, whether the arc be large or small.

The Frank and Caro process consists in the forming first, in an electrical furnace, of calcium carbide, and then passing nitrogen over this material when at a red heat, the result being that the nitrogen combines with the calcium carbide forming cyanamide. It is essential for this process that the nitrogen should be free from oxygen, and this is obtained by fractional distillation of the air (Linde) in the manner now used for producing oxygen. It will be seen from this that oxygen is given off as a valuable by-product.

In all the processes except that of Frank and Caro, the object is to produce $NO_2 + NO$, which, when combined with water, gives a mixture of nitric and nitrous acids. From these is then usually produced nitrate of calcium, which is the fertilizer sold. In the last process the cyanamide is sold direct, and decomposes slowly in the presence of water, giving off ammonia, which is absorbed by the soil or taken up by the plants. It is worthy of remark that this substance assists the production of nitrifying micro-organisms, which themselves are germinated in large quantities and sold for use as active fertilizers.

MOTOR DRIVEN CASH REGISTER.

Utilization of an electric motor to drive a cash register is one of the latest departures. The cash register is only used for about one-half second at each operation and the number of operations made in a day is high at one thousand, so that the time the mechanism is actually in service is relatively short. It was, therefore, considered impractical to use a motor which would run continuously, it being desirable to have an efficient machine which would be able to start, do its work and stop in about one second. On



MOTOR DRIVEN CASH REGISTER.

direct current this would be a comparatively easy matter. It was thought best to utilize a motor which would be universal for all currents so far as the mechanism was concerned.

A motor was therefore designed with the idea of using the same armature for all currents involved and of making the magnetic field of such a nature that different voltages and frequencies could be compensated for in the field turns of the motor. This resulted in the design of a motor able to operate on any commercial circuit that will light an incandescent lamp. The registers are con-

structed to operate on anything from 40 to 500 volts direct current and on alternating current circuits ranging from 100 to 250 volts and frequencies from 10 cycles to 140 cycles per second, the actual power required of the motor being about ⅛ horsepower.

The object of utilizing electric motors on cash registers is to eliminate the turning of the handle of the register. Certain keys are depressed on the register representing the amount of the sale and then the key representing the clerk or person making the sale is pressed. This automatically turns on the current, operates the register, and then the motor stops; all this being done in about ⅔ of a second.

HILL CLIMBING BY ELECTRICITY.

School buildings always look very well, situated on the top of a hill, but untold toil is expended by the generations of students in reaching them. One enterprising institution has overcome this

HILL CLIMBING BY ELECTRICITY.

objection by building an incline railway with double track, cable hoist and cars capable of carrying 20 passengers up the steep grade.

One car goes up as the other comes down, one balancing the other. The drum which carries the cable operating the cars is driven by a 20-horsepower electric motor.

THE ROMANCE OF RUBBER.

Next to copper and iron, rubber is the most important material in the electrical industry. It is used extensively as an insulating material, being one of the best insulators of electricity in the world. Nearly all the wires that carry electrical current are protected with rubber insulation. Rubber prevents the electricity escaping through contact of the wire with other conductors; it prevents accidents, fires, and keeps the electrical apparatus from burning out and destroying itself.

Many primitive uses were found for this wonderful gum, but owing to its susceptibility to changes of temperature, which rendered it sticky and more or less fluid, rubber did not come into its own until early in the last century. At that time it was discovered, after a great deal of experiment, that by mixing sulphur with crude rubber and subjecting it to a high degree of heat, these former deficiencies were eliminated and a material was produced which was both tough and elastic, and would retain those properties under varying temperatures. This process of curing was called vulcanization and is the basis of rubber making today.

So great has been the development of rubber manufacture since that time that its products now exceed a value of five hundred million dollars annually.

Contrary to the popular impression, rubber gum is not derived from the sap. It is secured from a milky juice or latex which is found only in the bark. This latex contains a substance known as caoutchouc (the active principle of rubber), together with certain albuminoids, resins, etc., which upon the evaporation of moisture coagulate, forming a thick, spongy substance. The percentage of caoutchouc, in proportion to other ingredients contained in the latex, determines the quality of the rubber.

The regions from which rubber gum is secured form an irregular belt in the tropics and sub-tropics extending around the earth, the quality procured varying greatly according to the species of plant, the soil and the climate.

Rubber gathering in the Amazon River district is a hazardous and difficult

undertaking. The supply comes from wild trees scattered throughout dense forests, to which paths must be cut through the tangled and luxuriant undergrowth. Even then, the trees can only be reached during three to five months of the year, as throughout the wet season the forests are completely inundated. The climate is so unhealthful that white men cannot do this work and it is necessary to rely upon the native blacks, who at best are undependable and lazy. Their reluctance to join rubber gathering expeditions can readily be understood when it is remembered that out of a season's expedition perhaps only half will return alive.

When a rubber tree is found the native gatherer cuts a series of gashes into the bark with his machete, encircling the tree from the ground up, as high as he can reach. Cups are fastened to catch the latex as it oozes out. When a sufficient quantity is collected it is removed to the temporary hut where a dense smoke-producing fire is made of certain nuts and palm leaves. Then taking his wooden paddle the native dips it into the latex and holds it over the fire, turning it round and round until the latex coagulates. As soon as it is hard a new layer of latex is added and coagulated as before. This process is continued until the mass has grown too large for handling, when the paddle is taken out and the rubber set aside for export. The process of coagulation and fumigation with these specially selected nuts and leaves prevents decay and adds to the life and wear resistance of the manufactured product.

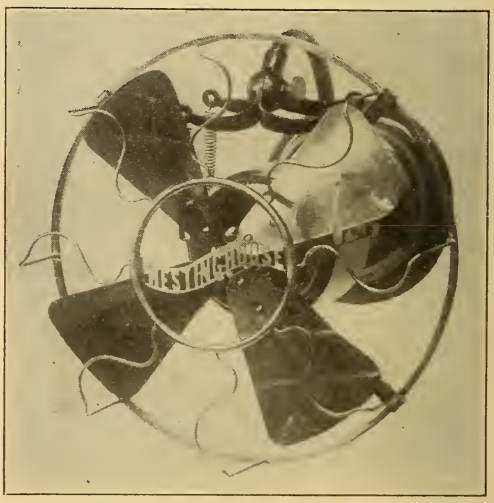
TESTING GRAIN.

Mr. Lyman J. Briggs of the Bureau of Plant Industry has invented a method of testing the moisture content of grain by its electrical resistance. The importance of the invention depends upon the desirability of knowing accurately the condition of grain in storage or in transit. An electric current is passed through the grain from one metallic electrode to another, and a form of the apparatus has been devised suitable for employment in cars and elevators. Thus far the experiments have been confined to wheat. Heat plays an important part, since the resistance rapidly decreases as the temperature increases, and so the temperature has to be taken into account. The moisture content can be determined by this method with a probable error not exceeding three per cent. The electrical resistance of wheat containing 13 per cent of moisture is 50 times that of wheat containing 15 per cent of moisture.

TELEPHONE BOOTH FAN.

Everyone is familiar with electric fans and knows what a relief they are in the summer time for offices and for houses, but their use is being extended to another field where they are as much appreciated. To anyone who has occasion to use long distance telephone booths at all it will be a source of pleasure to know that an eight-inch fan is now on the market which can be used to keep the air in circulation in the booth.

These fans look like toys and some people have facetiously said they would



TELEPHONE BOOTH FAN.

do for a watch charm, but they are far from being mere toys. The blades spread but eight inches while the motor is not half that size. The motor is supported by springs from an arm screwed to the side of the booth, and may be tilted or turned through a wide range of directions. The springs pre-

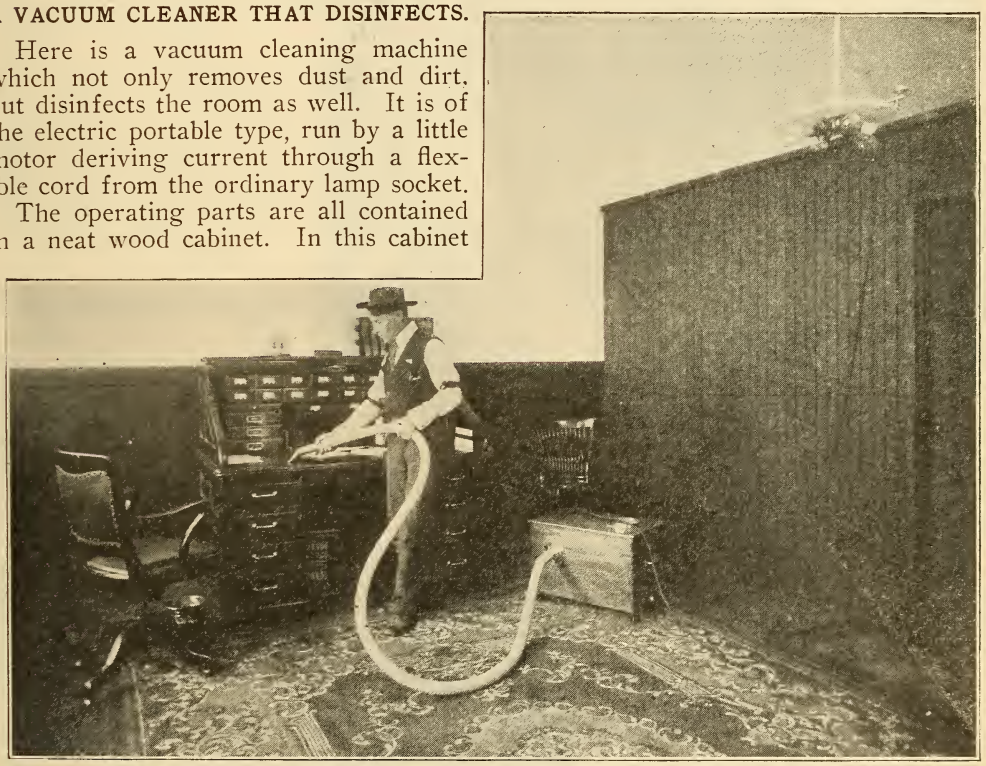
vent any transmission of vibration from the motor to the telephone, and as the fan is noiseless the effect is to blow the impure air out of the booth and bring in fresh without in any way affecting the use of the telephone. As booths are usually provided with several small holes the air is circulated even with the door closed, but of course the best ventilation comes when the door is opened.

The fan is kept running all the time and consumes about one quarter of the current required by an ordinary 16-candlepower carbon lamp. A regulating switch is provided in the base of the bracket from which the motor is suspended, by which the speed may be adjusted to three values, any one of which may be used for running indefinitely. The movement of the air is dependent upon the speed of the fan, as is the amount of power required. In some booths the lowest speed of the fan is sufficient. At the usual rates for power, 10 cents a kilowatt-hour, it would cost a cent and a half to run it all day long.

A VACUUM CLEANER THAT DISINFECTS.

Here is a vacuum cleaning machine which not only removes dust and dirt, but disinfects the room as well. It is of the electric portable type, run by a little motor deriving current through a flexible cord from the ordinary lamp socket.

The operating parts are all contained in a neat wood cabinet. In this cabinet



A VACUUM CLEANER THAT DISINFECTS.

is the motor which drives an exhaust fan, which sucks air through the long flexible tube. Inside the box, the dust is separated from the incoming air and then this same air is passed through a disinfector, which has previously been saturated with a one per cent solution of hydroformaline or a five per cent solution of carbolic acid. It is possible in this way to thoroughly disinfect the air in an office or an entire house

LARGEST ELECTRIC WATER POWER PLANT.

The largest electric power station in the world will shortly be erected within fourteen miles of Johannesburg, S. A., under the terms of a contract officially announced, by which the Victoria Falls Power Company will supply electric power to practically all the mines in that great group.

ELECTRIC CARS ON A BANQUET TABLE.

Recently in San Francisco there was a convention of central station men and distributers of electric automobiles and their equipment. They met to discuss ways and means of furthering the use of electric vehicles, for the charging of automobile batteries is becoming an important line of central station business. During the convention a banquet was given to the delegates by one of the large storage battery manufacturers, and a unique feature of the banquet was the installation of a miniature electric car running on a track extending entirely around the table. This car was operated by a storage battery and carried messages and cigars to the guests.

ELECTRIC CARS ON A BANQUET TABLE.

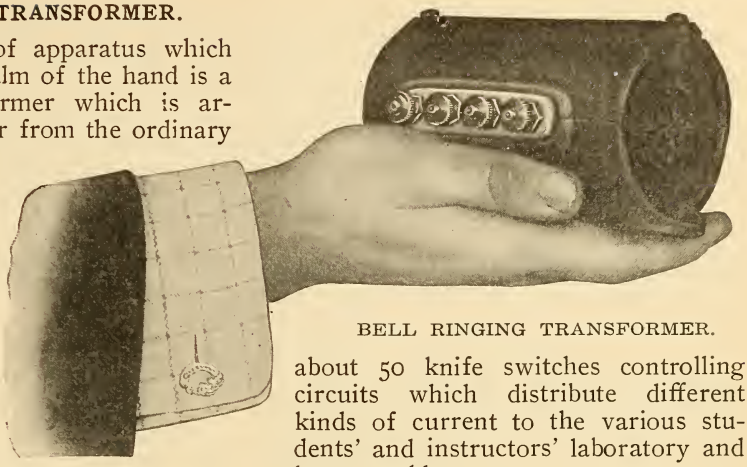
KUCH'S QUARTZ LAMP.

The mercury lamp, invented by Arons and greatly improved by Cooper Hewitt, is well known. Its distinguishing characteristic is its unpleasant blue-green light, and the peculiar shape of the lamp itself, which, for 110 volts, is over a yard long. The mercury vapor therein is in a very etherial condition. Such a lamp will burn about 1,000 hours and take about 0.6 watt per Hefner candle-power: Dr. Küch has shown that with increased current this lamp shows at first decreased efficiency, but with still further increase of current there is a second increase in efficiency, so that it is possible, by taking advantage of this fact, to produce a more economical lamp. But here comes in the difficulty that at a temperature of 60° C. or 127° F. the glass tube of the ordinary mercury lamp commences to soften. To get around this difficulty Küch made a lamp out of melted quartz and increased the current still further. Naturally the temperature of the mercury rose proportionately, and the lamp, instead of working under vacuum had an internal pressure of one atmosphere. Considerable economy was effected, as the current necessary was reduced from 0.6 watt per Hefner candle-power to only 0.3; further, the lamp was in more convenient shape. A lamp for 220 volts is, for instance, only about six inches long. The color of the light could not be called beautiful; being much like that of the old mercury lamp, but not so unpleasant as that, as the new one emits considerable red light also. This is very plainly seen when one places a lamp of each kind behind a red transparent disk. The quartz lamp shines brightly, while the other is almost invisible. The quartz lamp is made for 2.5 to four amperes and 110 to 220 volts. The watt consumption per candle-power when the lamp is provided with reflector, etc., is for the lower hemisphere, about 0.3 watt. The lamps can be set in almost any ordinary factory and are readily interchangeable. They may be used for photographing, copying, for drying patent leather, for sterilizing liquids (by reason of the germicidal effect of the ultra violet rays); under water, by reason of the lack of sensibility of the quartz to change in temperature; and for medicinal purposes. The life of such a lamp is given as about 1,000 hours, continuous operation.

A wireless telephone is to be used along the coast as a fog signal. It has been tried out and found to work well under heavy weather conditions.

BELL RINGING TRANSFORMER.

This little piece of apparatus which can be held in the palm of the hand is a bell ringing transformer which is arranged to take power from the ordinary 110 volt, alternating lighting circuit and change it to the proper value for operating electric bells, buzzers, etc. It is made with several taps in the secondary winding so that six, 12 or 18 volts may be obtained at will. It requires no attention, thereby placing it in direct contrast to the ordinary battery, which is frequently out of order at the times when it is needed most. The core and coils are placed in a small metal box with lugs attached for convenience in fastening to the wall or ceiling.



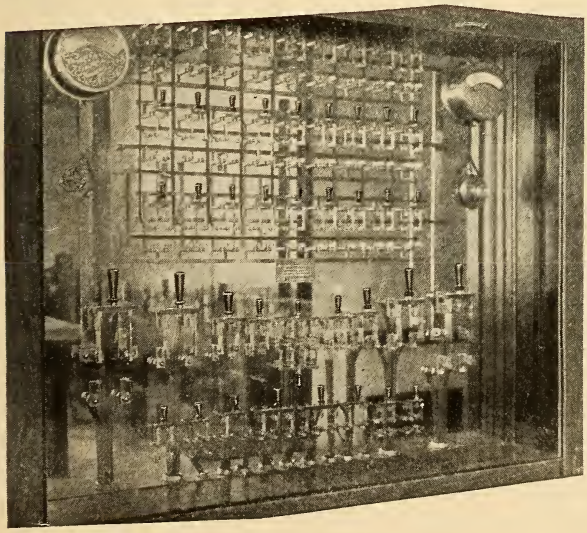
BELL RINGING TRANSFORMER.

A GLASS SWITCHBOARD.

Plate glass is an unusual material for the construction of a switchboard, slate or marble being ordinarily used. A unique board of this kind has, however, been constructed for the private laboratory of the San Jose High School, in San Jose, Calif. On this board are about 50 knife switches controlling circuits which distribute different kinds of current to the various students' and instructors' laboratory and lecture tables.

These currents, direct and alternating, are of various strengths. One circuit may ring an ordinary electric bell, another of great capacity furnishes a heavy current flow for making experiments requiring many amperes, at low voltage. High tension direct current may be had, also alternating current for the transformers, some of which step the voltage up as high as 100,000 volts.

The glass board is one inch thick. It is five feet high and six feet long, all in one piece, and is placed inside of a fine cabinet with plate glass doors. All bus bars, as the rear conducting bars are called, are of copper, highly polished and lacquered. The whole equipment, though somewhat expensive, presents a very handsome appearance.



A GLASS SWITCHBOARD.

ULTRA VIOLET RAYS TO PURIFY MILK.

Two scientists in Lyons, France, are said to have made the discovery that milk subjected to the ultra-violet rays emitted by Krohmayer's mercury vapor lamp will be completely sterilized. The milk is run through a glass pipe and exposed but a moment to the effect of the rays. These ultra-violet rays, by their chemical effect, kill any germs which are present in the milk.

POPULAR ELECTRICITY WIRELESS CLUB.

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine is devoted to the interests of the Club and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments.

SPARK COIL CONSTRUCTION AND OPERATION.

BY V. H. LAUGHTER.

PART II.

Before going into the actual construction of the secondary it will be advisable to explain some of the features and technical terms. In the previous chapter we learned that the secondary of a spark coil is a large amount of small wire wound on over the primary, which is composed of a few layers of heavy wire. The two windings are insulated from one another by an insulating tube. The operation of the vibrator in the primary circuit sets up a current of several thousand volts in the secondary. Great care should therefore be used in the insulation of the secondary, as otherwise the results will be poor, due in the usual cases to a "breakdown" or short circuit across the windings.

In coils of the ½-inch size and over, it is necessary to divide the secondary up into sections. That is, the total amount of wire to be used in the secondary is wound in several spools or sections and the sections assembled with an insulating substance placed between them and the exposed terminals connected so that one continuous winding is formed.

In a coil of the ½-inch size only two sections would be necessary, while in a 2-inch size six would be needed. The number of sections increases with the size of the coil. If the secondary is not properly insulated the previously mentioned breakdown is liable to occur, which ruins the efficiency of the coil, and makes it necessary to rewind the whole to find the faulty portion. The best method is properly to insulate the secondary at the beginning. If the coil were wound without sections, it would be an easy matter for the "breakdown" to occur, as the adjacent turns of the different layers would carry widely different voltages, and the insulation would very probably be punctured and a short circuit result.

By dividing the secondary up in sections and insulating the sections from one another, the danger of a "breakdown" is reduced to a minimum as the turns in each individual section carry voltages which do not differ widely from each other, and there is no danger of puncture. As a further precaution the secondary terminals of a coil should never be held so far apart that the spark breaks across at irregular intervals for this places the secondary of the coil under a great strain and is liable to cause the breakdown.

SECONDARY WINDING.

To construct a secondary for the four inch coil under consideration, the following apparatus and materials are necessary: Winding machine, section former, five pounds number 34 single silk covered magnet wire, about five pounds of insulating material, and 40 or 50 sheets of ordinary size filter paper.

The secondary in this instance will be divided up into 16 sections, although in the table of dimensions to appear in a later chapter a greater number of sections is recommended, but considering the special method of winding used in this case, the 16 sections will answer. The size of wire to be used will largely determine the number of sections. For instance, if No. 36 wire were used in place of No. 34 the number of sections should be increased to at least 24. The silk covered wire is used in preference to the cotton covered, as it offers more perfect insulation, and the thin covering allows a greater number of turns to be wound in a certain space than the cotton covered, although the cotton covered can be used.

A view of the secondary sections is shown in Fig. 6. The length from end to end is eight inches and the diameter 3¾ inches. As the secondary is to be wound in 16 sections this will give a width of ½ inch to each section and a diameter of 3¾ inches, therefore the

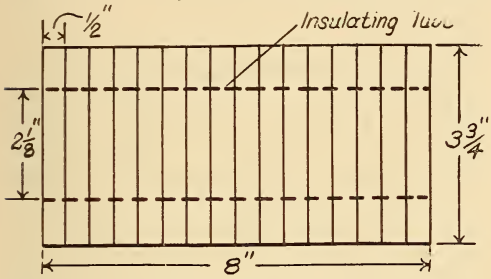


FIG. 6. CONSTRUCTION OF SECONDARY SECTIONS.

section former will have to be made to conform to these dimensions.

WINDING MACHINE.

The winding of a secondary for even the smallest size coils is a tedious job if attempted by hand, and can be best accomplished by some type of winding machine. The turning lathe makes an excellent winding machine, although it is not usually found in the amateur's shop, so usually he is thrown on his own resources to supply some type of machine that will answer.

In connection with the winding device is a bucket which holds the insulating substance, the substance being kept in a boiling state and the magnet wire drawn through, so that a certain amount of the wax will adhere to the covering over the wire. This serves to hold the wire in place on the section former, and provides insulation.

Several kinds of insulating substances can be used, but a mixture of paraffine and beeswax in equal proportions will prove ideal. The beeswax gives a higher melting point to the mixture, and should by all means be added if the coil is to be used in warm climates.

The general constructional plan to be followed out in the winding machine is shown in Fig. 7. (A) represents the original spool of magnet wire, (B) the small guiding spool, (E) a large drive wheel belted to a smaller pulley on the section former, (G) the paraffine receptacle consisting of the tin bucket (F) placed inside of a larger one (G). Between the two, water is poured which prevents the paraffine from becoming overheated and catching fire. The alcohol lamp (H) keeps the paraffine in a boiling state.

The exact method to be used in constructing the machine can of course be changed to suit the ideas of the builder, but the same general plan should be followed out, for it is very essential that the paraffine be applied to the wire as the winding operation proceeds.

For the supports and the base it is best to use heavy two-inch wood so that no vibration will occur when the crank handle is turned.

The drive wheel at (E) in a type of this machine that the writer used was the lower drive wheel of a sewing machine, and the upper wheel (C) was the upper pulley. The two were mounted on the support, being held in place by bolts. The lower wheel was provided with a handle for turning as shown. It is evident that a dismantled sewing machine would make an excellent winding device, as foot power could be used

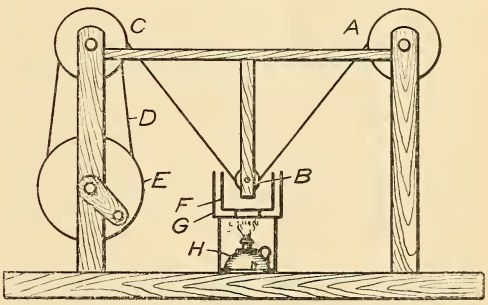


FIG. 7. WINDING MACHINE.

for driving, allowing both hands free to guide the wire.

SECTION FORMER.

Considering that the winding machine has been constructed the section former will be next taken up.

The method of winding in this case will be known as the double-section plan which is far more convenient and easier to connect with other sections than with the single-wound section plan.

The sections will measure from 3¾ to four inches in diameter, and as the insulating tube over which the sections are to be placed measures 2⅛ inches in diameter, the sections must necessarily be

wound on a mandrel of this size. The view of a section former is shown in Fig. 8. It consists of brass plates (A A A), 1/16 inch thick and four

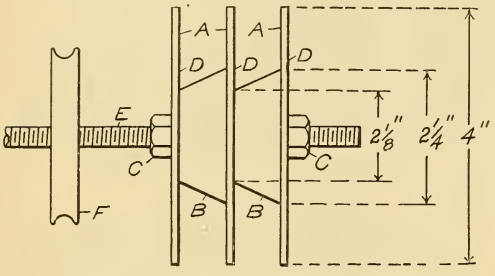


FIG. 8. SECTION FORMER.

inches in diameter, mounted on the bolt (E) with wood cones (B B) placed between, and held in position by screwing up the nuts (C C). The supports which hold the section former in the winding machine should be slotted in order that the section former can be easily removed when the winding of a section is completed. The ends of the bolt rest in these slots and the pulley (F), Fig. 8, then becomes the upper pulley shown in Fig. 7.

The wood cones (B B) measure 2⅛ inches in diameter at the smaller end and 2¼ inches at the larger end. This will allow the cone to be pushed from the center of a wound section without disarranging the winding. Small holes (D D) are drilled in the plates through which the end of the magnet wire is led.

Before beginning the winding cut 80 or 90 sheets of common filter paper to the exact diameter of the disks (A) and with central diameters to make a neat fit over the wood cones, the holes in half of them being 2⅛ inches in diameter and in the other half 2¼ inches.

Considering that the section on the right hand side of the former is to be wound first, place two sheets of the filter paper against the inner sides of the brass plates. Lead the end of the magnet wire from the spool (A), Fig 6, around the guiding spool (B) on up to the section former and to the left through the small hole (D), of the middle plate, taking several turns around the left hand cone to hold it in place.

Begin turning the handle of the drive wheel and guide the magnet wire over the space between the plates, as evenly and smoothly as possible. The winding should not be carried on too fast, but the speed should be such that the magnet wire will reach the coil being formed before the wax had time to set. A number of authorities recommend that the winding be carried on with the former immersed in the boiling parafine solution; this plan is of course the best where the coils are manufactured for commercial use, but the amateur would find this a difficult method, and the plan as given above will be followed out.

The first section should be wound with exactly three ounces of wire, and for the rest of the sections an estimate can be made of the wire required, as each section will hold approximately the same amount of wire in the space as determined for the first. The most reliable method is to weigh the original spool of magnet wire before the winding is begun, and after the estimated amount has been wound on, the difference between the two weights will be the amount on the section.

Considering that the first section is wound on the former on the right hand side, the section former is now taken from the bolt and turned around so that the wound section is on the left hand side. The middle face plate is removed and the cone and the other face plate screwed up against the wound section. This will leave the inside terminal of the wound section exposed. The end of the magnet wire from the spool is brought to the section former as before, but instead of being led through the hole in the face plate, it is connected to the exposed end of the wound section.

The connection is made with a drop of solder and a small amount of tape wrapped over the exposed portion. This section when wound will fit up closely against the first section with only the filter paper between. The necessity for turning the former around is apparent for this will make the two winding, or commonly called double section, continuous. Seven other double sections are wound in this manner.

The next operation is the boiling-out process. Place the sections one by one in boiling paraffine and continue to boil

until all bubbles have ceased to appear at the surface. The sections are next placed in cool linseed oil and allowed to soak well for an hour or so. The sections are now completed and will be laid aside for the final assembling which will be taken up at a later point.

(To be continued.)

BUILDING A "PERICON" DETECTOR.

BY ALFRED P. MORGAN.

Certain metallic oxides and sulphides possess the remarkable property of rectifying electrical oscillations. These crystals conduct current better in one direction than in the other; that is, their conductivity is unidirectional. Prof. G. W. Pierce has shown that in the case or carborundum the current at a pressure of 10 volts may be one hundred times greater in one direction than in the other. As the voltage is raised this ratio decreases.

The crystals also exhibit a remarkable regenerative power or are able when inserted in the antenna circuit to rectify electrical oscillations into a pulsating direct current which produces sounds in the telephone receivers without the aid of a local battery.

The following is a partial list of the minerals and crystals possessing these properties and which may be employed as "thermo-regenerative" detectors in radio-telegraphy or telephony.

Material and Chem. Name.	Formula.
Carborundum—Silicon Carbide	SiC
Fused Silicon—Silicon	Si
Iron Pyrites—Iron Sulphide	$Fe S_2$
Copper Pyrites—Copper Sulphide	$Fe Cu S_2$
Chalcopyrites—Copper-Iron Sulphide	$Cu_2 SFe_2 S_3$
Hessite—Telluride of Silver or Gold	
Zincite—Zinc Oxide	ZnO
Octahedrite, or Anastase—Oxide of Titanium	$Ti O_2$
Stibnite—Antimony Sulphide.	$Sb_2 S_3$
Molybdenite—Molybdenum Sulphide	MoS

The "pericon" detector is one of the most important of the many crystal detectors. It offers many advantages over the electrolytic. When once carefully adjusted it will remain so for a long period unless it is roughly handled or burned out by placing near a strong transmitter and not properly shunted.

For some reason or other mystery has more or less surrounded the construction of a "pericon" detector. In reality it is very simple and consists of two mineral pellets properly mounted and placed in contact with one another.

It is well to buy from a reliable dealer in wireless telegraph supplies a pound of each of the two minerals, chalcopyrites $Cu_2 S Fe_2 S_3$ and zincite ZnO. The large lumps are broken up into small bits and tested by placing a fragment of each in contact with one another in a crystal detector.

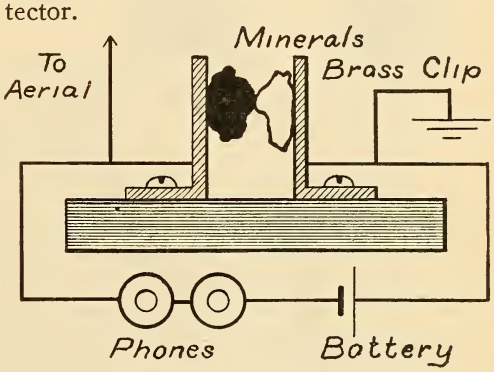


FIG. 1. SIMPLE FORM OF CRYSTAL DETECTOR.

A simple form of crystal detector is shown in Fig. 1. Two spring clips are fastened to a block of wood. This is connected up as a usual detector and the test made by placing different fragments of the minerals between the springs and listening to the signals in the telephones. In this manner the relative merits of the different specimens may be found and the best specimens selected to be set permanently in the cups.

The most sensitive pair is selected and each is mounted in a brass cup, similar to the ordinary silicon detector, as shown in Fig. 2. The minerals are mounted so as to project about 1/16 of an inch above the edges of the cups. The zincite ought to present a flat surface and the chalcopyrites a rather blunt point. The latter mineral is set to one side of the centre of the containing cup so that by revolving, the blunt point may be brought

into contact with any part of the zincite.

Since heating the chalcopyrites is liable to reduce its sensitiveness somewhat, the metals are mounted in a composition known as Wood's metal. Wood's metal is an alloy consisting of four parts of bismuth, two parts lead, one part of tin and one part of cadmium. This alloy melts at 137.8° F. The cups are thoroughly cleaned and brightened inside and then poured nearly full of melted Wood's metal. The minerals are pressed in the molten metal and held there until it cools and hardens, as shown in Fig. 2.

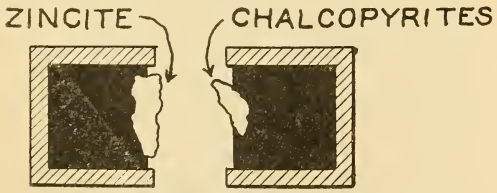


FIG. 2. METHOD OF MOUNTING THE CRYSTALS.

Fig. 3 shows the scheme of a "pericon" detector. The base measures 5½ by 3 by ¾ inches and is preferably of hard rubber. The posts (A) and (B) are mounted 2½ inches apart and are 1½ inches long and ½ inch in diameter. They carry threaded rods (P) and (P¹) which are made of brass ⅛ of an inch in diameter and two inches long. Two hard rubber disks (CC) 1½ inches in diameter and ½ inch thick are bored and threaded to fit the rods. They serve as

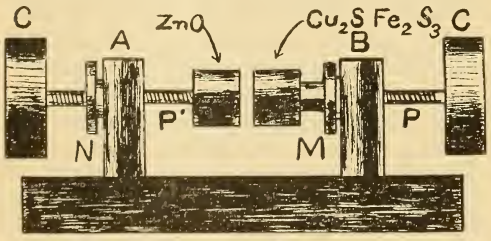


FIG. 3. PERICON DETECTOR.

insulating handles to adjust the detector. The rods are threaded the entire length so as to screw into the standards (A) and (B). Lock nuts (M) and (N) are provided to fasten the plugs in position when adjusted. A spiral spring is placed between the lock nut (M) and the chalcopyrites cup. The tension of the spring should be just strong enough to bring the minerals into light contact. The tension is adjustable by the nut (M).

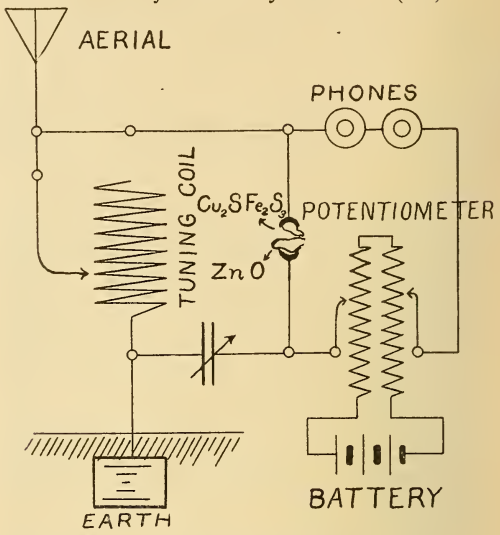


FIG. 4. THE PERICON DETECTOR IN CIRCUIT.

Connections are shown in Fig. 4. The battery is so connected that the current flows from the copper to the zinc. When connected up such a detector if nicely adjusted will prove very satisfactory even for amateur work.

THE AMATEUR AND PROFESSIONAL OPERATOR.

The right of amateur operators to cast messages to the "winds" promiscuously, thereby interfering with the work of commercial and government operators, has been questioned, and there has been considerable newspaper discussion on the matter of legislation to prevent this. While it is not probable that such legislation will be passed, still it is for the amateur to remember that although the all-penetrating and imponderable ether is free as the air, still there are certain ethical rules which should be followed in wireless telegraphy as in any other line of work.

Wireless telegraphy is one of the most interesting forms of experiment in all the electrical field for the amateur. It is a good thing, but, to use a very slangy expression, which seems to fit the case, don't let us "kill it." It is not always policy to try and get in touch with every government and commercial station. Every fleeting message which the operators

of these stations may receive does not give them the same joyous thrill which is experienced by the enthusiastic amateur who has just got his apparatus to working after, perhaps, many trials and failures. You wouldn't think of connecting a telegraph instrument somewhere out on a commercial line and then calling all the operators along the line for a morning salutation.

The situation is quite aptly set forth by Mr. O. S. Van Olinda, one of the readers of Popular Electricity who takes this subject seriously. In a recent letter for the benefit of the Wireless Club, he writes:

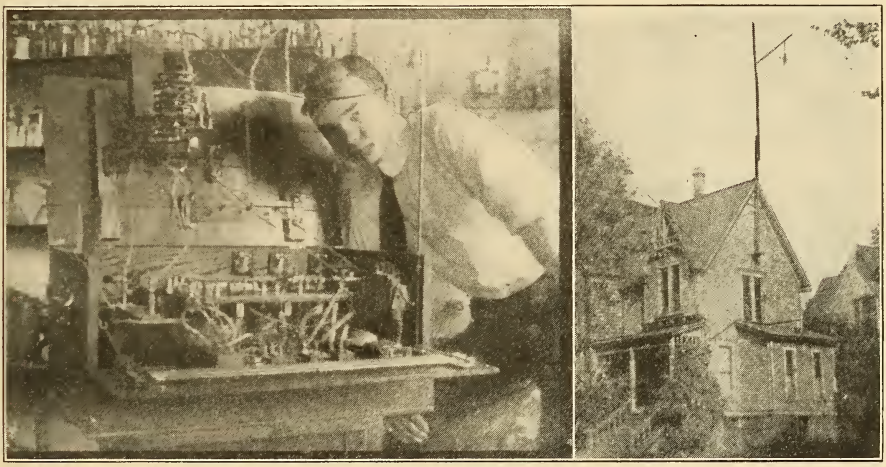
"Amateurs and experimenters in wireless would do well to remember that the operator at a naval or commercial station is placed there for the sole purpose of doing business and those higher up expect him to do the best he can to get his 'stuff' through. It has been my experience that wireless operators, as a class, are a very broad-minded and accommodating set of men and the amateur owes it to himself to be as considerate as possible and do all he can to avoid the necessity of restrictive or prohibitive legislation. The writer does not believe that laws regulating wireless would be held constitutional, but we may be able to save a lot of expense and trouble if we can get along without laws, and every electrical journal, amateur and experimenter should assist in a campaign of education along that line."

A FORTY MILE EQUIPMENT.

Harold S. Pratt of Elgin, Ill., has accomplished very good results with apparatus which is largely of home construction. The views show the operator with his portable sending and receiving set also the mast on the rear of his residence which supports a 60-foot antenna. His portable set which is of the Marconi type, includes a three-inch coil, call relay, bell, sounder and tapper, condensers, choke coil, etc.

In his laboratory the youthful experimenter also has a complete equipment for long-distance work, and with it he has been able to communicate with Chicago, which is 40 miles distant. This equipment contains, among other things, a two kilowatt transformer.

The mast and antenna support are of the jointed kind and are fastened to the side of the house, leading up over the roof where the second joint is spliced on. This is a very simple and efficient method for erecting masts for experimental purposes.



A FORTY-MILE EQUIPMENT AND ITS OPERATOR.

WIRELESS TRAIN SIGNALING.

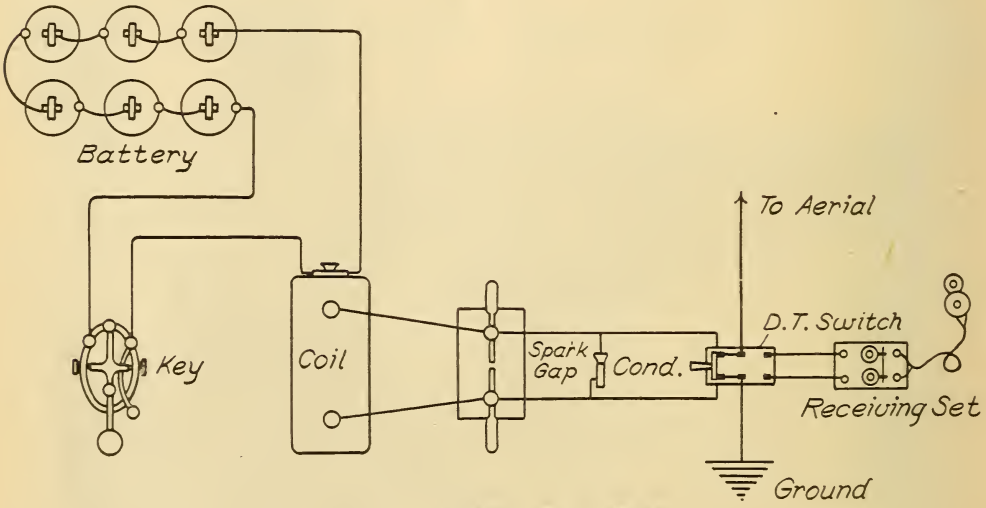
Wireless communications have been successfully carried on from a special train on the Lake Shore Railroad to Cleveland and Chicago, while running at full speed. From the results of experiments so far it is anticipated that with perfected apparatus the system will be practical.

ONE TO FIVE-MILE EQUIPMENT.

BY C. BRANDES.

Most amateurs find it advisable to begin their experimental work with the construction of a small equipment capable of transmitting four or five miles. The following description and diagram will, therefore, be likely to fulfil the requirements of many who are just taking up the work. Under favorable conditions the apparatus will transmit from one to five miles.

The sending set consists of a one-inch



ONE TO FIVE-MILE EQUIPMENT.

A B C spark coil, which is specially built for wireless purposes, giving a fat, hot spark which cannot be obtained from X-ray coils and the like. Six dry batteries should be used to obtain good results. A zinc spark gap, a small condenser, and a key are also required.

The condenser is shunted across the spark gap, and a simple type which was found to work admirably may be made up by taking a glass test tube about six inches long, and covering it with tinfoil both inside and outside, within about two inches from opening. Contacts may be made on the outside by winding a piece of wire around outside of tube over the tinfoil, and on the inside by making a small V-shaped spring. The V-shaped spring should be spread a little wider apart than diameter of tube, so that when it is inserted it will press against the tinfoil inside the tube.

The writer has transmitted with a set of this kind from his laboratory in the tower of the Trinity Building, New York, to Manhattan Beach, a distance of about 12 miles. This may sound like exaggeration, but it is nevertheless a fact. The height of this tower from the street is about 375 to 400 ft. The aerial was suspended from the tower to a flag-pole on the other end of the building, a distance of 250 feet. The aerial was made of two strands of No. 12 galvanized wire, 250 feet long, looped. The conditions, therefore, were particularly favorable.

The aerial required for transmission of one to five miles should be from 20 to 60 feet high. This is all according to nature of surrounding country. Where there is woodland or other obstacles, a higher aerial is required than if you are located on an elevation or near water.

The receiving end may consist of the complete receiving set as described in February issue, or other types of construction previously described in this magazine.

A SIMPLE ZINC SPARK GAP.

Perhaps some of our wireless experimenters using spark coils, have never thought how easy an efficient zinc spark gap can be made at a slight cost. Zinc has been found to be the best material for a spark gap owing to its peculiar qualities. The writer has made one which has proven very satisfactory and is as good as those for which you pay as high as $1 and upwards.

Secure a piece of well-seasoned wood and cut four by seven inches, having a thickness of about one inch. Bevel the corners and plane the surfaces smooth, after which apply a coat of shellac. When this is dry, a coat of wood stain of any desired color can be applied which will make a better appearance. Next secure two common battery zincs, such as those used in sal-ammoniac batteries, having screw terminals at the ends where connections are made. These zincs when purchased are usually square half of the length and round the other half. If a lathe is at hand, these can be turned down to a round surface, or can be filed down, as zinc is almost as soft as lead. Secure two porcelain cleats of the two-wire kind, with wood screws, and fasten them on the finished board about two inches from each end. Before tightening down, the zincs can be inserted between each of the cleats and the spark gap adjusted and screwed down tight. The gap can be adjusted by loosening up the screws in the cleats.

WIRELESS QUERIES.

ANSWERED BY V. H. LAUGHTER.

Marconi and Electrolytic Detectors.

Questions.—(A) Please tell me if I can make and use a Marconi magnetic detector, and is it more sensitive than the electrolytic

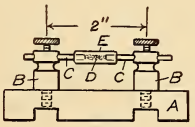


FIG. 1. SIMPLE COHERER.

detector? (B) What is the most sensitive coherer that can be used in connection with the relay and how is it made? H. H. L., Tacoma, Wash.

Answers.—(A) The Marconi magnetic detector is not nearly as sensitive as the liquid, silicon and numerous other types on the market at the present day. We would recommend that you construct the electrolytic kind, which is wonderfully sensitive and simple. A detector of this type is shown in answers to H. L., this issue.

(B) One of the most simple coherers is the ordinary metal filings kind. First, get a suitable wood base (A), Fig. 1, seven inches long, three inches wide,

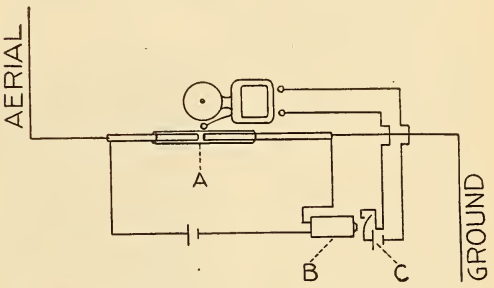


FIG. 2. COHERER CONNECTED FOR RECEIVING.

and one-half inch thick. Two large binding posts are now mounted on the base as shown at (B B). The binding posts should have a side hole of sufficient size to allow the insertion of a 1/16 inch brass rod. Next get two brass rods, two inches in length, and amalgamate the ends by dipping first in acid and then in mercury. The brass rods are now mounted as shown in the sketch with the two inside ends separated about 1/16 inch, and a glass tube that will make a neat fit is slipped over the ends. Between the two ends of the rods as indicated by (D) are placed the metal filings. The filings can be made of nickel with a trace of silver added, using a very course file in the preparation. Sift in a thin cheesecloth to allow all the fine dust to escape. The decoherer, which can be a common electric bell, is mounted on the base so that the hammer will hit the glass tube when in operation. The exact adjustment can best be found by actual experiment. The manner of connecting the coherer for receiving is shown in Fig. 2. The coherer is shown at (A) in circuit with the battery which operates the relay (B). The battery (C) operates the decoherer.

Wireless Operation.

Questions—(A) Can a relay be made to operate in conjunction with a carborundum detector for calling? I have a one-inch spark coil connected to an aerial 65 feet high and want to operate about one mile. (B) Which is better for the above use, the carborundum or microphonic detector? About how far would I be able to receive with this set, employing a detector of the above named type. (C) Which is the stronger, a magnet wound with one hundred feet of number 20, or one hundred feet of number 36, and how much? (D) Does it work just as well with either pole of the spark coil connected to the aerial? —E. L., Peoria, Ill.

Answers.—(A) The carborundum detector cannot be used in connection with the relay or bell signaling device. The construction of a coherer receiving set is described in the answer to H. H. L. this issue.

(B) If adjustment is perfect the carborundum detector is the more sensitive. You should be able to receive from commercial stations from 50 to 100 miles away.

(C) The magnet wound with 100 feet of No. 20 wire would be the stronger, as it will allow more current to flow through the turns. It would be impossible to give the exact difference in strength between the two without knowing the size of the magnets, the number of turns and the current flowing through each.

(D) In practical use no difference will be noticed.

Automobile Spark Coil; Liquid Detector.

Questions.—(A) Will an automobile spark coil do for wireless? (B) How is a liquid detector made? H. L., Hutchinson, Kan

Answers.—(A) Yes.

(B) A liquid detector can be made according to the accompanying plan. (A) represents a wood base 5 by 3 inches

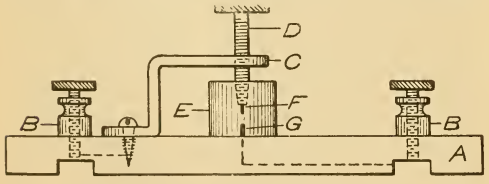


FIG. 1. LIQUID DETECTOR.

and ½ inch thick. Binding posts (B B) are mounted near the ends of the base. (C) is a metal standard ½ inch wide, ⅛ inch thick and 1½ inches in height when bent to the shape shown. A thumb screw (D) is mounted on the standard with the .0004 Wollaston wire clamped in a slit at the end as shown at (F). (E) represents a glass cup with the platinum wire (C) soldered in the bottom. Leads are carried from the platinum wire in the cup and from the metal standard to the respective binding posts.

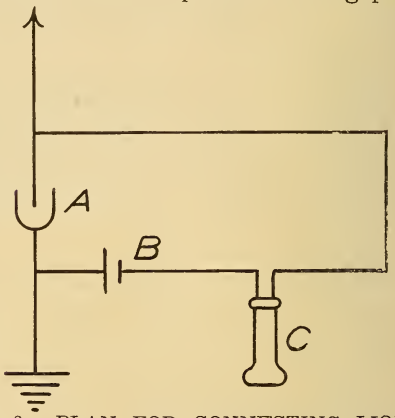


FIG. 2. PLAN FOR CONNECTING LIQUID DETECTOR.

The cup should measure approximately ½ inch in diameter and ¾ inch deep. The cup is filled to about three-fourths of its height with a 20 per cent solution of sulphuric acid. The plan for connecting is shown in Fig. 2. (A)represents the detector, (B) the battery and (C) the telephone receiver.

Tuning Coil; Detector; Receiver Resistance

Questions.—(A) In making a tuning coil could I use a smaller wire than that used to make the tuning coil described in the July issue? (B) In making the liquid detector like described in the July issue what size cup should be used to hold the acid? (C) How can I determine the resistance of a telephone receiver? L. F., South Whitely, Ind.

Answers.—(A) A smaller size could be used but is not recommended.

(B) About ½ inch in diameter and ¾ inch high.

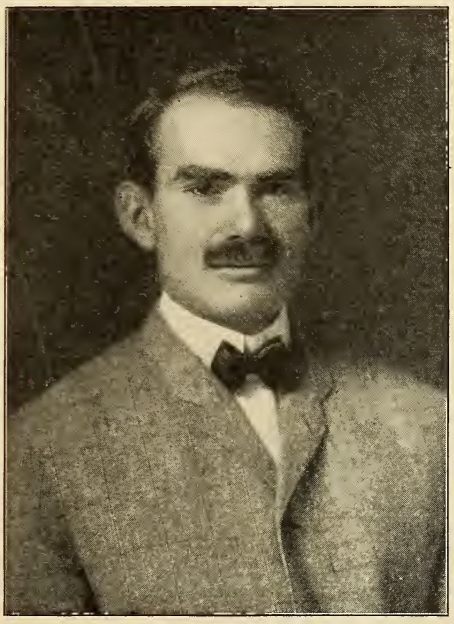
(C) A simple method would be by use of a volt meter, battery, and several known resistance spools. Connect the volt meter, battery, and receiver in series, and note the point at which the indicating needle of the volt meter rests. Next connect the known resistance spools in the circuit in place of the telephone receiver and continue to change the resistance until indicating needle rests at the same point.

ELECTRICAL MEN OF THE TIMES.

LEE DE FOREST.

Experience has taught us that the dreams of to-day are likely to be the realities of to-morrow. Two years ago speech could only be projected through space as far as human lungs would permit. To-day we have the wireless telephone, so far developed that conversations have been carried on over a distance of several hundred miles.

Among the half-dozen inventors who have done most to develop wireless telegraphy and telephony is Dr. Lee De Forest. He is a young man, only 36 years of age, but, the cares which have been his, in developing his various inventions and securing the recognition which was justly his, have accentuated in his face the lines of grim determination of his Huguenot ancestry.



Dr. De Forest was born in Council Bluffs, Ia., in 1873, although his early boyhood was spent in Alabama. He prepared well for his work, being graduated by Sheffield Scientific School of Yale (electrical and mechanical engineering) in 1896, and after three years of post graduate work receiving the degree of Ph. D. from the same institution.

It was about this time that the Hertzian wave theory had astounded the scientific world, and it interested him deeply, so much so that he wrote his doctor's thesis on the subject and made the wireless transmission of intelligence his life work.

The first year out of college was spent in the telephone experimental laboratory of the Western Electric Co., with the short-lived American Wireless Telegraph Company of Milwaukee and as assistant editor of the Western Electrician of Chicago. Determined, however, to continue his wireless experiments he resigned from the last position and attended Armour Institute for one year, where he could have laboratory facilities. Here he developed the electrolytic receiver to a commercial stage, testing it later at the international yacht races in 1901, when the Shamrock II was defeated.

Soon after, the De Forest Wireless Telegraph Co. was formed, called afterwards the American De Forest and finally the United Wireless Telegraph Co. During this interval he developed his general system of wireless telegraphy, including transmitter, tuning devices and sending transformer. All did not go smoothly with the company, however, and it was reorganized. De Forest thereupon severed his connection entirely, assigning all patents to the reorganized company, but retaining the right to use them himself as sole licensee.

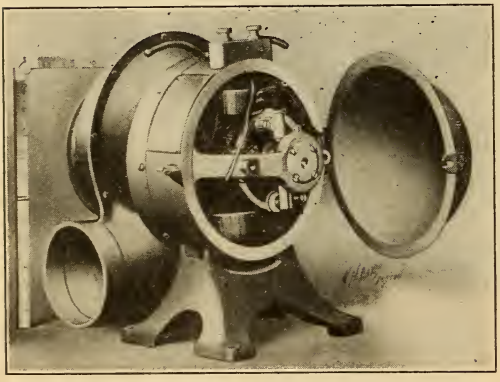
In the fall of 1906 he began his experiments on the wireless telephone, following out previous ideas, and in the spring of 1907, after several successful demonstrations of the apparatus, the Radio Telephone Company was formed. In February, 1908, he went to Paris, France, and demonstrated his apparatus on the Eiffel tower. During this test the long-distance record was made, gramophone music being heard at a naval station near Marseilles, over 550 miles away. His system was also used successfully on the ships of the famous Pacific Squadron.

ELECTRICITY IN THE HOUSEHOLD

THE "READY-TO-RUN" ELECTRIC FAN.

The uses of electric current have now become so numerous that we need not be surprised to see almost any machine operated by electricity. Among other applications the electric motor has been applied to various ventilating devices which have been in the nature of fans, both of the propellor type and of the cased type.

Of the propeller types of fan, the desk is most common, while we generally think of a cased-in fan as one large



THE READY-TO-RUN ELECTRIC FAN.

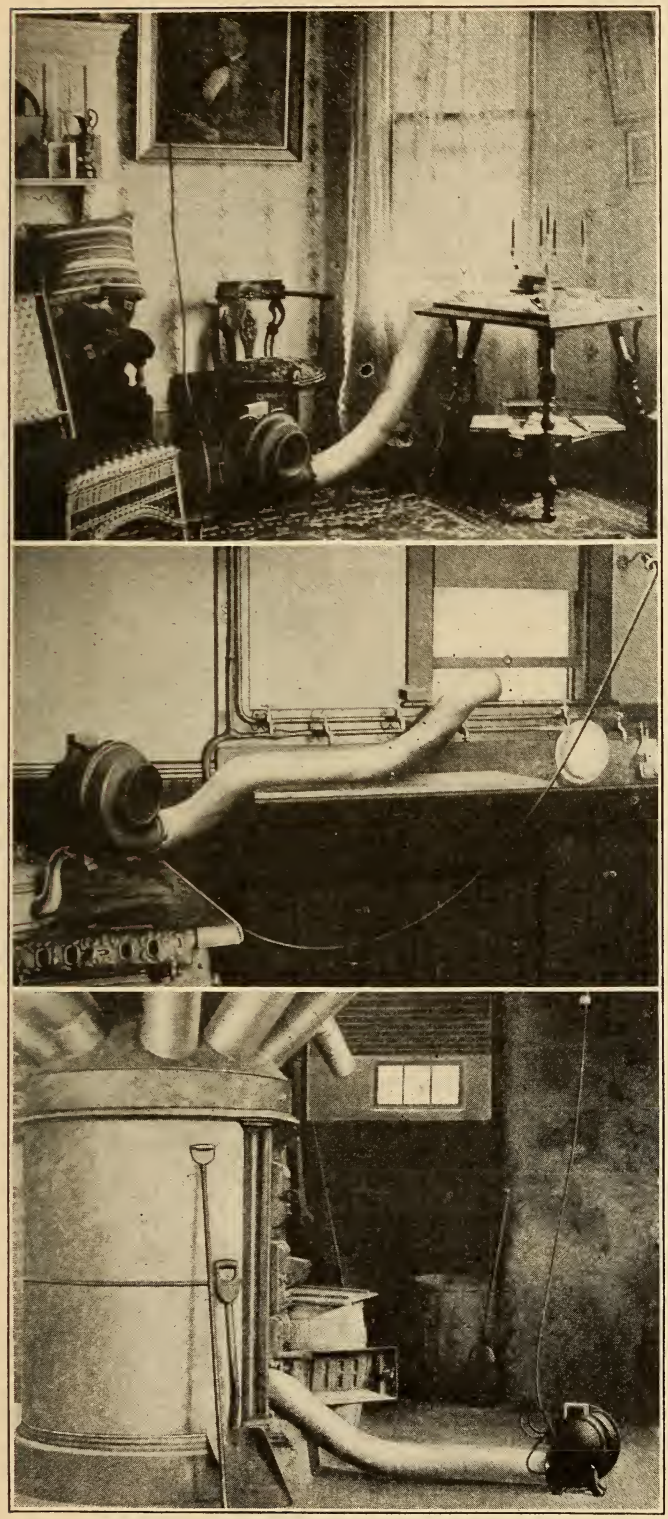
enough to supply ventilation for a public building, factory, hospital, or schoolhouse. It is true that comparatively few attempts have been made to produce a fan of the cased type in small sizes; the matter of expense being the principal obstacle. However, the cased fan has certain advantages over the propeller type; in fact, it is infinitely superior for certain conditions.

Due to the slight expense, it has been customary to ventilate rooms in residences, large offices, such as banks, accounting rooms, and private offices, by desk fans. This method has not proven altogether satisfactory, due to the fact that the desk fan merely stirs up air but does not produce real ventilation. Some people have fancied that cool air is necessarily pure, while others imagine that they are being made comfortable simply because the air in a room has been set in motion. Just here lies the difference between real ventilation and apparent ventilation.

To produce real ventilation, the overheated air must be removed to allow fresh air to take its place. With a desk fan real ventilation is practically impossible, while with a small cased fan it is not only possible but is actually being accomplished in many places.

To meet these conditions, a cased fan has been designed which has the good features of the desk type, in that it is of moderate cost, requires but a small amount of electric current, and is so light that it is easily carried from room to room. The disadvantage of the desk fan, that of merely stirring up the air, has been entirely eliminated, for, the fan being of the cased type, it positively and noiselessly removes the overheated air. With the fan is furnished a flexible canvas hose about 20 feet in length, so that the fan may be placed anywhere in a room within 20 feet of the window and the overheated air discharged to the outer atmosphere.

The set is made in three sizes, the smallest of which weighs but 25 pounds, while the largest weighs only 50 pounds. They are equipped with either a direct-



VARIOUS APPLICATIONS OF THE READY-TO-RUN ELECTRIC FAN.

current motor or an alternating-current motor, the armature of which is mounted upon the same shaft as the fan wheel. The set requires so little power that it can be run by the lighting circuit. It is an exceedingly convenient little set and has been given the name of "Ready-to-Run," for no installation is necessary. It can be set in operation by simply putting the plug, which is at the extremity of the cord furnished for the purpose, into the electric light socket and turning the switch.

In the residence, clubhouse, or hospital, the fan is used for clearing the atmosphere of tobacco smoke, cooking odors, etc., in a manner shown in the illustration, and it is also used for blowing the furnace when the natural draft is insufficient. Among other uses may be mentioned the ventilation of small rooms such as sick rooms, telephone booths, motor-boat cabins, etc., and in factories and power houses, it is also efficient for local ventilation and for blowing dust from machines.

The automatic electric egg-boilers, like those on the Lusitania and Mauretania, are able to cook 200 eggs at once, a clock arrangement causing the basket containing the eggs to hop out of the water at any half minute up to six minutes. Another novelty is a self-dumping oyster-cooker for stews. At the expiration of a given time the cooker pours its contents into a soup plate and automatically shuts off the electricity.

ECONOMY OF ELECTRIC LIGHTING.

The economy of electric lighting is very near to the hearts and pocketbooks of all users of electricity for lighting purposes. It is a broad statement, and one that will surely cause some surprise, when the electrician tells us that electricity is the most economical light for the home, if used right. "If used right," that is the secret and yet how few of us understand enough about the mysterious current to use it at its best advantage.

It is not vaulting over the borders of truth to say that in nearly every home now using electric light the regular monthly bills could be cut down fully twenty per cent with a little care and attention and a little more knowledge about electricity and electric lights.

If the householder who complains about the electric light bills from month to month will observe the following rules he will find that the cost for lighting his home is nothing unreasonable. And it is the desire of any progressive lighting company that these rules be followed, for a satisfied customer is a constant advertiser of the benefits to be derived from central station current.

Don't waste light.

Use the smallest candle-power lamps which will do the work required.

Use reflectors for close work.

Keep a few of the new metal filament lamps on hand for use where a large amount of light is required for any length of time. They will pay for themselves many times over.

A blackened lamp means a dimmed light. Throw it away. Paying for current to operate a dim light is the height of extravagance. One new lamp will often give as much light as two old ones.

Don't spoil a good lamp by surrounding it with a light-killing shade. Many of the ornamental shades are nothing more or less than fancy glass light-sponges which absorb most of the light rays.

Rooms finished in dark colors require more light than rooms finished in light colors.

Don't expect to light your house in winter as cheaply as you do in summer. It is impossible, for there are several hours more of daylight in summer than in winter.

The daylight brightness of an ordinary room, into which the sun is not directly shining, was found by an illuminating engineer to be commonly not more than 1/10 candle-power and sometimes as low as 1/100 candle-power per square inch. Most artificial lights have a much greater intrinsic brightness, and this accounts for their injurious effects when the eyes are not shielded from their full glare. He concludes that a diffused light of 1/5 to 1/10 candle-power per square inch is best. Strain and injury to the eye have been attributed to ultra-violet light, but such light is less in various incandescent illuminants than in direct or even reflected sunlight.

COST OF ELECTRIC HEATING AND COOKING.

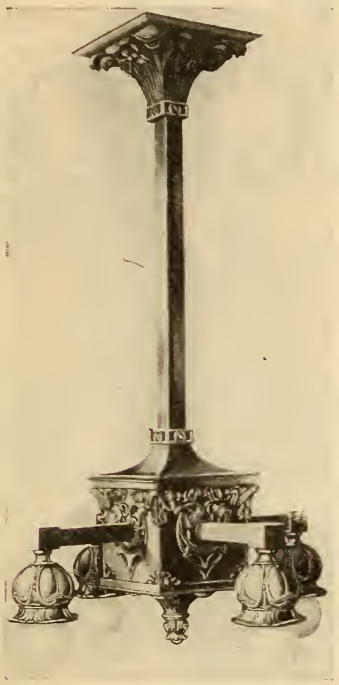
Electricity is beginning to take the place of the coal-stove in the home and it is promised by men who look wisely into the future that within a few short years a large portion of the cooking and heating will be from electric power. Already a great many homes contain an electric kitchen wherein all the cooking and baking is done in electric ovens and electric heated utensils. A capable engineer recently tested the heating devices used in his own home and prepared the following table to show their economy:

COST OF ELECTRIC HEATING AND COOKING DEVICES—10-CENT PER KILOWATT HOUR RATE.

Electric Flatiron, 3 lbs.	2½c. per hour
" " 6 lbs.	6c. " "
Pint Water Heaters...	3c. " "
Quart Water Heaters..	3c. " "
Two-qt. Water Heaters	10c. " "
Six-qt. Water Heaters.	13c. " "
Combination 4-quart Cooker	10c. " "
Tea Kettle 4-quart....	3c. " "
Coffee Percolators	3c. and 5c. per hour
Chafing Dish	3c. per hour
10-inch Stove	12c. per hour
Frying Pans	5c to 13c. hour
Broiler	9c per hour
Oven	10c. " "
Corn Popper	3c. " "
Cooking and Baking Outfit Complete	$10 per month, average
Cigar Lighter	1c. per hour
Shaving Mug	1½c. " "
Heating Pad	½c. " "
Luminous Radiator ...	7½c. to 15c. per hour.

ART NOUVEAU ELECTROLIER.

One of the most pleasing of the new styles of electroliers recently produced is shown in the picture and is designed to carry Nernst lamps. It is designed



ART NOUVEAU ELECTROLIER.

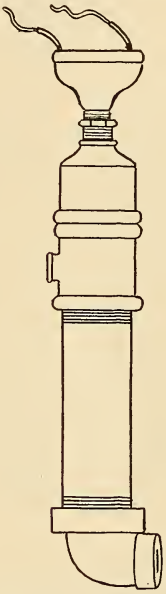
with either two or four arms, the ornamental treatment being pronounced without detracting from the fundamental simplicity of the design.

OPERATION OF THE ELECTRIC VIBRATOR.

H. B. P.—The reason your electric vibrator does not operate properly and gives only a faint and almost imperceptible "buzz" is undoubtedly because you are trying to use on an alternating current circuit a vibrator that is designed for direct current. The current supplied to most homes for lighting purposes is alternating in character; that is, it flows in first one direction and then in the opposite direction many times in a second. Such current will not operate a direct current vibrator of the plunger type. There are vibrators of the motor type on the market, however, which operate on either direct or alternating current.

INSTANTANEOUS WATER HEATER.

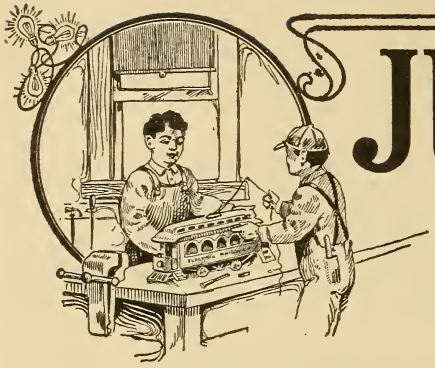
To provide hot water quickly for washing and cooking purposes the instantaneous electric water heater is a very convenient device. It is simple in construction, consisting of insulated carbon electrodes placed inside of an iron pipe. The current passes through the water from one electrode to the other. The sketch shows the heater as it would be attached to a wash basin, being placed directly in the cold water inlet pipe. When cold water is wanted no current passes through the heater. When it is desired to heat the water, the wall switch



INSTANTANEOUS WATER HEATER.

is turned so that current flows through the heater. A special advantage of the device is that should the current accidently be left turned on, no damage would result to the heater as would be the case were coils used to heat the liquid.

Chief Health Officer Levy, of Richmond, Va., recently stated through the columns of the Richmond newspapers that portable gas and oil stoves were a menace to health when allowed in living or sleeping rooms. The result has been a large demand in that city for the new electric luminous radiators which emit no noxious or deadly gases and do not destroy the oxygen in the air.



JUNIOR SECTION

SWITCHBOARD STORIES.

INSPECTOR NUMBER SEVENTEEN.

BY C. TUELLS.

It wasn't long after Marshall Wilder had been assigned to a bench in the meter repair department of the electric light company that the superintendent called him up to the office and, after telling him how satisfactory his work had been, presented him with a nickel-plated meter sealing tool that imprinted the company name and "Inspector No. 17" upon the lead meter seals, and told him that he was going to promote him to the inspecting department. He gave him the customary lecture that usually goes with a promotion, and concluded by telling him to report to the head inspector the next morning.

Marshall assumed his new duties with a cheerfulness that wasn't wholly actuated by the substantial increase in wages that accompanied his new job, for he found it a pleasant change from rewinding coils and soldering shunts. The outdoor life was also an agreeable feature, for fresh air is far ahead of soldering acid fumes and lacquer.

He ran across some peculiar cases during his inspecting experience. In one house he went into on his rounds he found the meter at a standstill. It was a prepayment or coin-in-the-slot meter, and on removing the cover he found stuck in the slot a quarter with a hole in it and a short copper wire attached. Upon questioning the lady of the house, she reluctantly confessed that for a long time that same quarter had kept the meter in operation. When the light ran low she would drop the quarter in until it started the mechanism and then pull it out by the wire and save it for the next time. She paid dearly for her petty dishonesty, however, for the company estimated the amount of current she had used (and they didn't get it too low), and she had to settle or go to court.

Then there was the case of Jacob Steinberg. He ran a clothing store and kept open every night in the week. His bills, however, had dropped off to only a dollar and a half or two dollars a month, so Inspector No. 17 was sent down to investigate. He went down into the cellar and read the meter and then turned on two lights upstairs in the store. The meter didn't even start. He turned on two more, and still it showed no change. Finally, with eight lamps going it barely began to register. When he took the casing from the meter he did not wonder at its tardiness, for every part of the mechanism was thick with a fine white dust. The wily Hebrew had heard that meters were not always dust-proof, and had purposely sifted all the ashes from his store right under and within two feet of the electric meter. Of course, he protested his ignorance, and Marshall could prove nothing, but the ash barrel was moved, just the same.

But for out and out rascality, one customer got ahead of them all. He complained to the electric company that his light was bad; didn't seem to light up his house properly—poor current, he

insisted. The head inspector turned the matter over to Marshall and he went down to locate the trouble, for trouble hunting was his business. Everything at the house looked all right, and if quantity of lamps was any advantage, it should have been well lighted, for there was a cluster or a chandelier in every room. His meter showed that

HE HAD HEARD THAT ALL METERS WERE NOT DUST PROOF.

very little "juice" was going through it —far below the amount necessary to light the house.

After looking around for awhile Marshall started to look for trouble along the line, commencing at the point where the wires entered the house. He didn't need to go far. Running his hand along the wires, he felt a pair of unexpected branch wires, leading upward in between the inner and outer walls of the house, and going upstairs he found that two-thirds of the lights were tapped from this circuit, which left the feed wires before they entered the meter. A closer investigation showed that a few of the lights were fed from the line after it went through the meter, which current, of course, had to be paid for, but on the whole the electricity used hadn't been costing much until Marshall arrived. That individual promptly reported the case to headquarters and the police were called in, with the result that the dishonest customer spent two years caneseating chairs—all because of the efficiency of Inspector No. 17.

BATTERY MOTOR CONTROLLER

BY F. R. FURNAS.

In using batteries for experimental work it is desirable to obtain different voltages and different current strengths for the operation of various pieces of apparatus, such as small motors, etc. This may be done by using resistance in series with the batteries, but the resistance wires of the ordinary rheostat absorb the energy of the battery and convert it into heat, which is a waste. A better way is to use a device which will enable one to readily make different groupings and arrangements of cells to accomplish the same result. Such a device is shown in Figs. 1 and 2, but before taking up the description it is well to understand how the different arrangements of cells will affect current and voltage.

One cell of dry or wet battery will give from one to two volts, according to its kind or condition. If we connect two cells in series, that is, the positive of one to the negative of the next and the two outside terminals free for connection to the motor, the voltage across the outside terminals will be twice as great as that of one cell. With three cells in series the voltage will be three times as great, and so on.

If, on the contrary, we connect cells in parallel, that is, all the positive to one terminal and all the negatives to the other terminal, the voltage across these two terminals will be equal to the voltage of one cell, but, of course, the greater the number of cells connected in this way, the greater will be the available power which can be obtained from the battery as a whole before it will run down.

Going one step further, the cells may be connected in what is known as series-parallel relation. For example, we may take three cells and connect them in series, giving three times the voltage of one cell and having an outside pair of positive and negative terminals. Then we may take three other cells and connect them in the same way. Then connect the positive terminals of the two groups of cells to one terminal of the motor and the negative terminals of the two groups to the other terminal of the motor. The voltage impressed upon the motor will in this case be the total voltage of one group of cells, or the voltage of three cells in series, but the current capacity will be twice that of one group.

To make these various combinations the apparatus above referred to will be found very handy, as it saves the trouble of changing battery wires every time a new voltage is desired. It works on the same principle as the street car controller and can be constructed at very small cost.

This particular controller is designed for eight cells of battery, and there are four "steps" or combinations available.

Make a wooden drum, as shown in

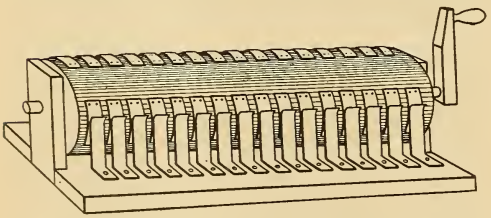


FIG. 1. BATTERY MOTOR CONTROLLER.

Fig. 1, and mount it on a board base, so that it may be easily turned by the handle. Take 16 strips of brass, zinc or other metal and bend them at right angles. Then mount them on the base, as shown, so that their upper ends will touch the circumference of the drum. To these we will connect our power plant of batteries permanently, as shown in Fig. 2. On the drum tack four rows of metal strips so that they will rub under the angle pieces as the drum is turned. Two of these rows are shown in Fig. 1.

Next connect these various strips of metal together by wires, as shown in Fig. 2, which is a diagram drawn as if the surface of the drum were spread out flat, showing all four rows at once.

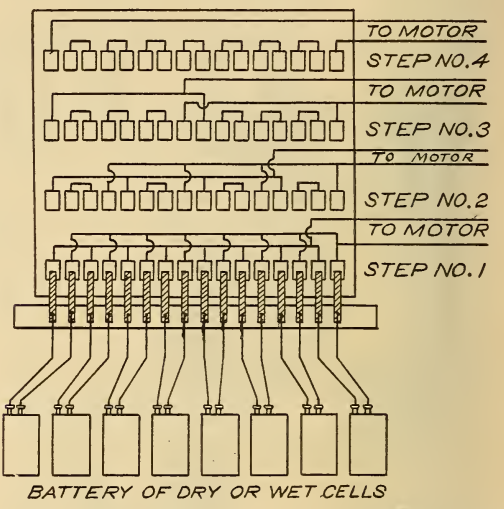


FIG. 2. CONNECTIONS OF BATTERY MOTOR CONTROLLER.

By carefully tracing the connections in each of the four steps it will be readily seen that in step No. 1 all the eight cells are in parallel, giving the voltage of our cell. When the drum is revolved so that step No. 2 comes into position, the cells will be connected in series-parallel arrangement, consisting of four groups of two cells each, giving twice the voltage of one cell. Step No. 3 is a series-parallel arrangement of two groups of four cells each, giving four times the voltage of one cell. In step No. 4 all the cells are in series, giving eight times the voltage of one cell.

Various mechanical means of connecting the different steps of the controller with the wires leading to the motor, so as not to conflict with the turning of the drum, will suggest themselves to any ingenious experimenter.

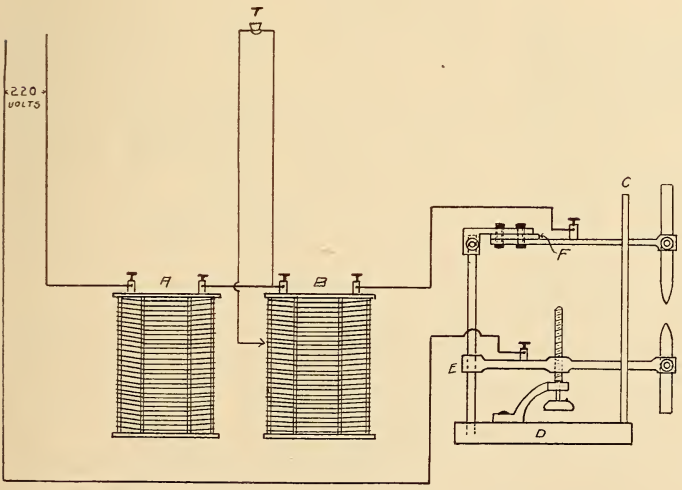
The first practical demonstration in this country of the new process of telegraphing photographs was made March 4th, when pictures of Taft and Roosevelt were flashed over the wires between Washington and New York.

HOW TO MAKE A SPEAKING ARC.

BY B. E. BLANCHARD.

A speaking or singing arc, as it is called, is by many considered a difficult device to arrange and secure good results. The writer has within the last month demonstrated this pleasing experiment several times, connections for the same being made as shown in the diagram.

A hand-feed arc lamp similar to the one shown should be used. The base (D) is of wood. (E) slides up and down the shaft or rod, regulating the distance between the carbon tips. Insulation between carbons is provided by the fibre or mica plate, (F), the bolts passing through fibre cylinders. (C) represents asbestos board, slitted to allow the arm (E) to move up and down, and is quite necessary in keeping the rear part of the lamp and the hand feed mechanism cool. (A) consists of a hexagonal frame of iron, each rod having a layer of one-eighth inch asbestos between it and the wire wound upon it. The wire used is No. 14 Krupp resistance wire, 81 turns or 95 feet being wound on each coil,



METHOD OF CONSTRUCTING SPEAKING ARC.

(A) and (B). Connect the coils as shown, taking off a tap at the binding post of (B) for one side of the telephone transmitter circuit. Then while someone sings or whistles steadily into the telephone transmitter, (T), move the other lead represented by the arrow, up and down the coil (B) until the arc while burning gives out the singing distinctly. A transmitter taking 2.5 amperes without heating gives good satisfaction, the lower its resistance the better. The writer used an International and also a Corwin.

The arc should be made as long as possible and one-half inch cored carbons provided. A third piece of carbon for starting the arc should be at hand.

Besides the human voice, the phonograph may be utilized, in which case the best results were obtained by removing the megaphone portion, and holding the transmitter close to the needle diaphragm. Results may be obtained on a 110-volt circuit, but the most satisfactory operation is from 220 volts.

BATTERY PLATE HOLDER.

Sheet zinc, on account of its brittleness when amalgamated, is not suitable for battery plates, but may be used for this purpose by fixing the plates between pieces of glass, which may be done as follows:

Cut the plate of the size required from a sheet of zinc; old zinc will answer the purpose. Cut two glass pieces the size of the plate. Solder a piece of copper wire to one end of the zinc to serve as an electrode, or else cut a narrow strip nearly off on the vertical edge of the zinc, and bend it upward to serve as the electrode. Then amalgamate the zinc, and fix it between the glass plates. This may be done by tying strings around the three plates at each end, by holding them together with strong rubber bands, or, more neatly, by means of sealing wax. The plate is then ready for use in the battery cell.

This easy, quick and cheap method of making zinc plates will prove very convenient for amateurs. The plates render good service, and last a long time.

QUESTIONS AND ANSWERS.

Readers of Popular Electricity are invited to make free use of this department. Knowledge on any subject is gained by asking questions, and nearly every one has some question he would like to ask concerning electricity. These questions and answers will be of interest and benefit to many besides the one directly concerned. No consideration will be given to communications that do not contain the full name and address of the writer.

Condenser; Mercury Arc Rectifier; Reactance.

Questions.—(A) Explain how a condenser in battery circuit is charged and discharged. (B) How does a condenser act on an alternating current? (C) Explain the operation of the mercury arc rectifier. (D) What is meant by reactance?—S. N., Milwaukee, Wis.

Answers.—(A) When one terminal of a battery is connected to the wire of a submarine cable, and the other terminal to ground, placing a galvanometer in the circuit, the galvanometer will show current flowing into the wire for quite a time before the galvanometer needle will

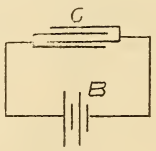


FIG. 1.

cease to be deflected. The energy represented by the charge pouring into the cable seems to be stored up in the form of stress. Similarly if a battery and condenser are connected as shown in Fig. 1, current will flow into the condenser and the plates will become charged. The most current will flow the moment the connections are made, and in the fraction of a second will cease to flow. The current will now act as if

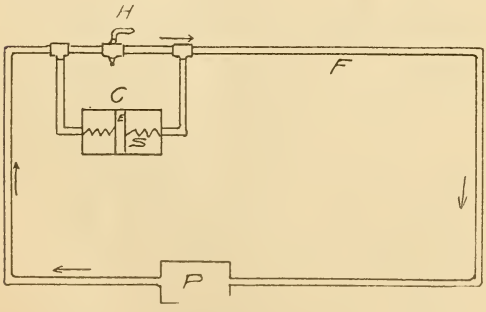


FIG. 2.

the circuit were broken. The condenser acts as if it had acquired a counter electromotive force equal and opposite to that of the battery. Now remove the battery, connect the terminals of the condenser together and for an instant current will flow and then drop to zero.

(B) With alternating current this charge and discharge takes place with the alternations. Fig. 2 may assist in understanding this further. (P) is a pump, (C) a cylinder and piston, the water being the carrier of energy. Allow (H) to be opened and let the pump set water to flowing through pipe (F) in the direction of the arrows. Now shut the valve. The water will continue in

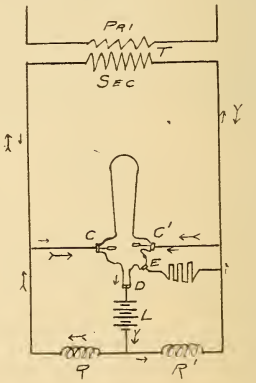


FIG. 3.

the direction of motion set up. On the left of the piston an excess of pressure will push piston (E) to the right and compress the spring (S). As soon as the flow ceases the stress in the spring (S) will give back the energy just given to it. The water in the pipe will follow, or a reverse current is set up until equilibrium is restored. If the valve (H) is opened too soon this reverse current must be overcome.

(C) The principle of the mercury arc rectifier is this: If current is made to flow in one direction between two points through mercury in a glass tube exhausted of air, and the direction of flow be suddenly changed, making what

was the negative electrode, positive, the current will cease to flow, because mercury displays the characteristic of opposing the change in direction and the formation of a new negative electrode.

Referring to Fig. 3 (C C′) are positive electrodes, (D) is the negative mercury cathode, (T) is a transformer, (L) batteries to be charged, (R R′) reactances, and (E) a starting electrode.

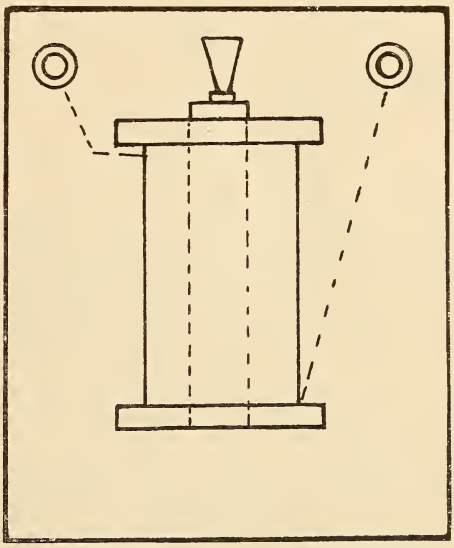
By tilting the tube to the right on starting the rectifier, a mercury path is made between (E) and (D), which starts the arc when the tube is restored to the vertical. Assume the direction of current to be as indicated by plain arrows. Current passes from (C) to (D) and through the load and reactance (R′). On the next alternation the tail arrows show the current from the other side of the transformer (T), passing from electrode (C′) to (D), through (L) and (R) to the other side of the transformer (T). Thus at all times through the load (L) current is flowing in one direction. The reactances (R) and (R′) at each reversal discharge, holding the arc until the voltage reaches the strength necessary to act against the counter electromotive force of the load. These reactances also smooth out the fluctuations in the direct current.

(D) If two wires are placed parallel to each other, and an alternating current passed through one of them, an electromotive force will be generated in the other wire at all times in the opposite direction to that in the first; that is, current would flow in the opposite direction if the two ends were brought together. This is due to the phenomenon known as induction. Now, if we take one conductor of any alternating current and place in it a coil of wire you will see that the current flowing in each turn of the coil will induce in each neighboring parallel turn an electromotive force in the opposite direction tending to oppose the electromotive force or voltage initially impressed upon the coil. Thus there is set up in the coil a counter electromotive force which opposes the voltage of the main circuit and holds down the current flow. This phenomenon is known as reactance. Direct current finds no resistance to its flow through such a coil, other than the ohmic resistance of the wire, because there is no rise and fall in the current and consequently no inductive effect of one coil upon the others. For full mathematical demonstration see any textbook upon alternating currents.

Choke Coil.

Questions.—(A) Please explain the action of a choke coil. (B) How may a choking coil be made? (C) Does a choking coil and a kicking coil perform the same service?—R. S., Chicago, Ill.

Answers.—(A) The passage of an alternating current through a coil of wire is opposed by an influence that chokes or impedes the current. This is due to the building up of a magnetic field in the coil. This choking effect increases with the frequency of the current and the number of turns of wire. If a mass of



CHOKE COIL WITH REMOVABLE CORE.

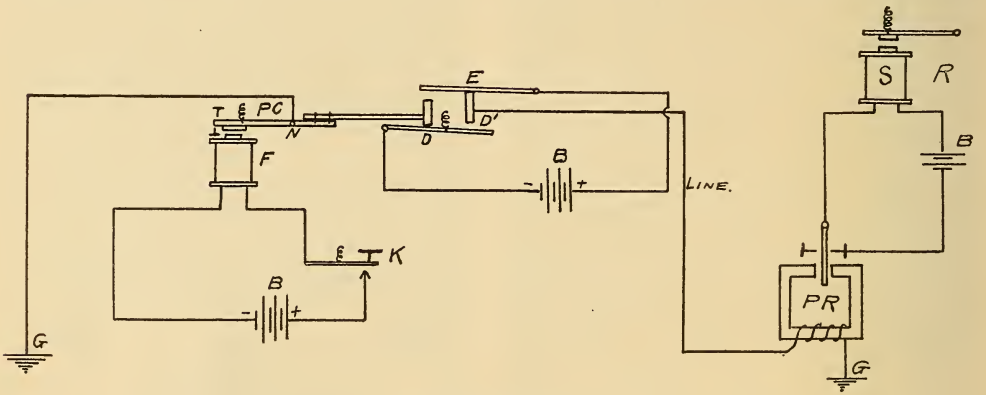
iron be placed inside the coil the magnetic flux will be increased because iron is a better conductor of such lines than air, and the choking effect of the coil will be still greater than without the core. This advantage of being able to choke the current without much loss is confined to alternating current. If as in a direct current a resistance is introduced, useless heat is set free, whereas by using a reactance coil as in a lamp circuit, current is choked with very little loss of energy.

(B) The diagram shows the arrangement of a coil in which the iron core may be moved. See answer to J. B., February issue, 1909.

(C) Yes.

Pole Changer; Care of Gravity Cell.

Questions.—(A) Will you please explain the operation of a pole changer and give diagram? (B) How long should a blue stone battery be worked? M. L. B., Princeton Jct., N. J.



POLE CHANGER.

Answers.—(A) A pole changer is used in what is called the polar duplex telegraph system. The pole changer serves to reverse the polarity of the battery to the line. The diagram shows a pole changer at station (K) and a polarized relay at receiving station (R). When key (K) is closed, relay (F) attracts armature (P C), which, resting on bearing (N) lifts contact at (D), closing contact at (D') and opening contact at (E) thus reversing the direction of current to line and around coil (P R) to ground. Armature of (P R) thus opens and closes circuit through sounder (S).

(B) This depends on the work the battery has to do. A pale or dirty brown colored solution indicates a bad condition of the cell. By the time a cell consumes three pounds of copper sulphate it should be cleaned.

Arc Lamp Coil; Wire Rheostat.

Questions.—(A) What kind of a device can I use in series with my hand adjusted arc lamp? (B) How can I make a simple rheostat of wire for use on a 110-volt circuit?—J. F. W., Seneca, N. Y.

Answers.—(A) See answers to T. W. P., May issue, and R. S. in this issue. See also answer to J. B., February issue, 1909.

(B) See "General Plan for a Home Made Rheostat," in the April issue.

Solenoid; Induction Coil; Condenser.

Questions.—(A) Will any current be generated in a solenoid moved around a closed magnetized iron ring, the ring being inside the solenoid? (B) Suppose there were an air gap in the ring; would this affect the moving solenoid? (C) How does the metal sheath outside the metal core inside some induction coils increase the secondary current when it is slid out of the coil? (D) How may one find the capacity of a condenser required to offer little impedance to an alternating current of given frequency and voltage as in the common battery telephone system? (E) If one terminal of an insulated primary battery be grounded would any current flow?—E. E. G., Madison, Ind.

Answers.—(A) and (B) A current will flow in a closed circuit coil whenever there is a change in the number of lines of force within the coil. A bar magnet moved into and out of such a coil will cause a current in the coil. If the coil is wound about a ring magnet we should say that no current would be produced in the coil because of the uniformity of the lines of force in the iron. If an air gap were made in the ring and the solenoid move about the ring, current would be induced in the solenoid coils moving over the air gap, as at that point the lines would change in density.

(C) The copper tube that slides over the iron core shields the iron core from the primary because the primary induces large currents in the copper tube itself on account of its low resist-

tance. The induced currents oppose the primary currents so that the resulting effect on the iron core is reduced. Withdrawing the copper tube allows the primary current to act directly upon the core.

(D) This is a problem where rigid rules cannot be laid down. Condensers for telephone purposes are of a high capacity built of alternate layers of paraffine paper and tinfoil.

(E) Not unless the other terminal be grounded, thus closing the circuit.

Hughes' Microphone.

Question.—I would like to construct a simple microphone. Will you explain how Hughes' microphone is made? J. J., Junction City, Ore.

Answer.—Fig. 1 shows the original microphone consisting of three nails. By

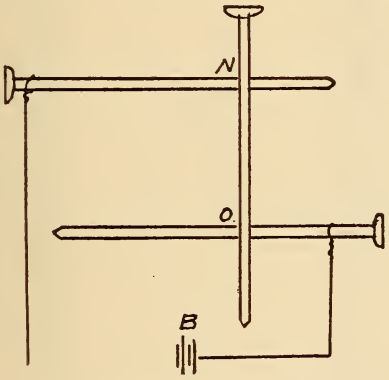


FIG. 1. HUGHES' NAIL MICROPHONE.

these, Hughes demonstrated the principle of variation of resistance of contacts (N, O) by vibration. Fig. 2 con-

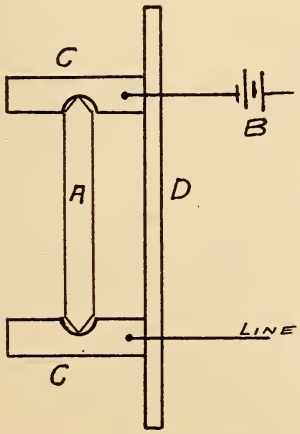
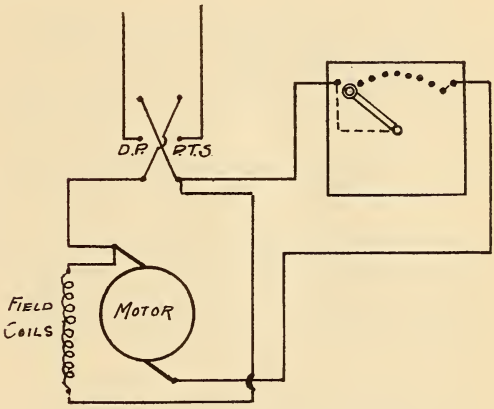


FIG. 2. HUGHES' CARBON MICROPHONE.

sists of a gas carbon pencil (A), pointed at each end and carbon blocks (C, C) fastened to a sounding board (D). The blocks (C, C) are hollowed out to loosely hold the carbon pencil (A) and are the points to which terminals of circuit are connected. The least noise near this instrument produces a very strong, loud vibration in a receiver in the circuit. The pencil (A) vibrates, varying the resistance of the circuit. The Blake transmitter described in the March, 1909, issue operates on the same plan. See also "Construction of a Simple Microphone," January, 1909, issue.

Installing Motor.

Question.—Please let me know how to connect up an eight horse-power motor, rheostat and pole changer. J. H. G., New York City.



SHUNT MOTOR CONNECTIONS.

Answer.—See diagram, showing connections for a shunt motor with rheostat in series with the armature winding.

Winding Relays.

Questions.—(A) Can a 75-ohm telephone receiver be wound for 1,000 ohms? How much and what size wire may be used? (B) How much and what size wire should I use to change a four-ohm relay to 20 ohms? H. G., Mountain View, Okla.

Answers.—(A) It is not practical to use a wire smaller than No. 40, B. and S. gauge. The resistance of 1,000 feet of No. 40 wire is 1,047 ohms; of the same length of No. 38 is 658 ohms.

(B) Use 600 feet of No. 25 wire. The standard 20-ohm relay is wound with 14 layers of 67 turns each of No. 25 wire.

Three Drop Annunciator and Bell.

Question.—Kindly advise how I can make an annunciator for a house call bell with three drops.—R. B., Scranton, Pa.

Answer.—In Fig. 1 you will find the

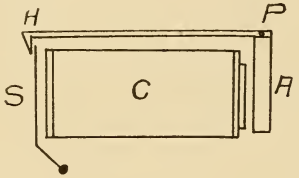


FIG. 1. PRINCIPLE OF THE ANNUNCIATOR.

principle underlying the construction of nearly all annunciators. When current flows through the coil (C) the armature (A) is attracted, and being pivoted at

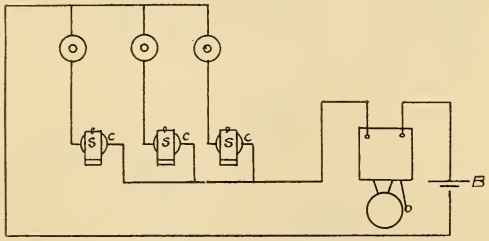


FIG. 2. METHOD OF CONNECTING THE THREE DROPS AND ONE BELL.

(P), the lever hook (H) rises and allows the shutter (S) to fall and display a number painted on its inside face. Fig. 2 shows method of connecting circuit for three drops and one bell.

Changing Motors Into Generators.

Questions.—(A) I have a motor that requires 110 volts to run it. I wish to change it into a generator. How may I do so? (B) How many volts would I get? (C) I have a motor which I tried to run as a generator, and I was told to magnetize the fields, which I did. I wish now to run it again as a motor, but on attaching batteries it will not run. The wiring or connections have not been changed. —R. G. W., Pittsburg, Pa.

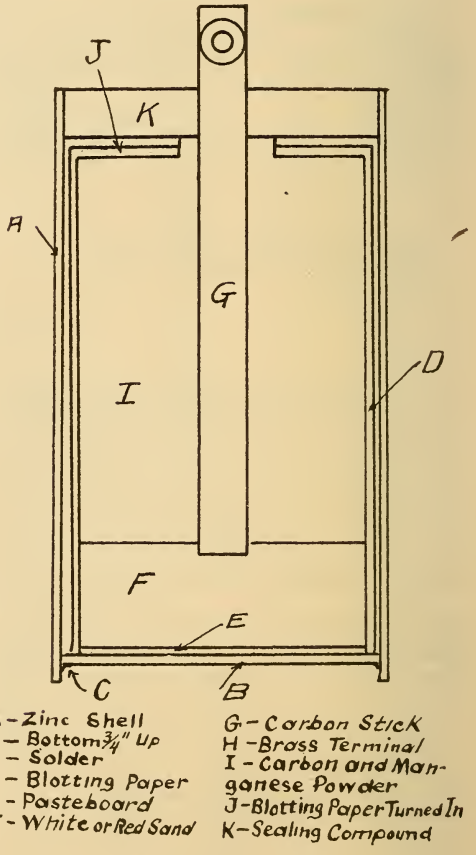
Answers.—(A) Connect the positive lead as a generator to the positive side of supply circuit and the negative lead to the negative side. Assuming a shunt-wound motor, it will run in the same direction as that in which it ran as a generator.

(B) You should be able to get 110 volts, varying the speed until the required point is reached.

(C) This is a difficult question to answer and the causes are numerous. Among them may be open field coil; broken wire in starting box; wrong connection of the shunt field; dirty brushes, etc.

Dry Batteries; Arc Lamps.

Questions.—(A) Will you explain how to make a small electric dry battery? (B) Why is a rheostat used with a stereopticon arc lamp? (C) Could an arc lamp be run by wires from a lamp socket with no rheostat in circuit? (D) Could an arc be used on a 220-volt circuit alternating or would it work best on a 110-volt direct current? F. C. S., McKees Rocks, Pa.



SIMPLE DRY CELL.

Answers.—(A) Place in a jar one pound of chloride of zinc crystals. Pour over them a quart of distilled water. Let stand for half an hour. Then pour the water off into a clean jar. If the crystals are not all dissolved, add a pint of water, let stand as before and pour into the first portion of the solution. When all crystals are dissolved, dilute the zinc

chloride solution thus obtained by putting in an equal amount of distilled water. Put sal ammoniac into this solution in the proportion of one pound of sal ammoniac to every two quarts of water. Set this aside, labeling it "Battery Solution."

To make the cell, take an already lined zinc can, blotting paper as shown in the sketch being the lining, and fill with battery solution. After the paper has absorbed some of the solution, pour it out and invert the can to dry out a little. Now mix finely powdered carbon and manganese wet with the battery solution until a stiff paste results. Put into the can the carbon center post with two tablespoonfuls of sand at the bottom. Now fill in with the paste, ramming down carefully. The sketch of the cell will make the rest clear. The top may be sealed over with paraffine wax.

(B) The ordinary arc lamp takes but 45 to 50 volts. When used on constant potential circuits of more than 50 volts, it is necessary to introduce a certain resistance in series, in order to take up part of the voltage, and also to act in a steadying capacity to the arc; until this dead resistance was used in series with arc lamps on constant voltage circuits, such lamps were not successful.

(C) A lamp socket is designed to supply only about one and one-half amperes to any device plugged in. See (B).

(D) A small transformer should be used in the first case, and a rheostat in the second.

Small Dynamo; Resistance and Voltage.

Questions.—(A) I have a ring armature six inches in diameter and three inches in length. If properly wound and revolved at 1,500 to 2,000 times a minute what voltage and current should I get? (B) Would it make any difference in the output if the field poles were ½ inch instead of one inch thick? (C) Would it make any difference if the armature was made of laminated iron disks instead of a solid iron ring? (D) Does a resistance in an electric circuit make any change in the voltage?—L. C. E., Wampa, Idaho.

Answers.—(A) Using 1¼ pounds of No. 24 wire on the armature, and 7 pounds of No. 24 wire on the field magnets you should get approximately 100 volts and 1½ amperes at the speed you designate.

(B) To push lines of force through a long magnet circuit requires more energy than to crowd them through a short one.

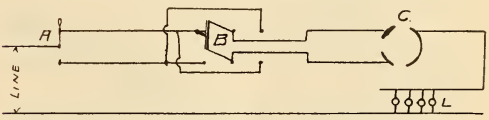
(C) By providing a laminated core for the armature, eddy current losses are eliminated.

(D) The fall or drop in voltage over any electric circuit is proportional to the resistance.

Mercury Resistance; Light Switch; Ruhmkorff Coil.

Questions.—(A) Can mercury be used as a rheostat? (B) Is it possible to arrange three switches so that lights may be turned on or off at three different points? (C) what would a Ruhmkorff coil giving a 2-inch spark cost?—E. L. A., Tacoma, Wash.

Answers.—(A) Mercury stands next



SWITCHING LIGHTS FROM THREE POINTS.

to silver and copper in conductivity and is hardly feasible to use as resistance.

(B) Diagram shows how connections may be made to control lights from any one of three points. (A) is a single pole, double throw switch. (B) is a double pole, double throw switch. (C) is a snap switch.

(C) List prices of two to 2½-inch Ruhmkorff coils range from $35 to $50, according to finish and enclosing cabinet. You might be able to get a discount from this cost.

BOOK REVIEW.

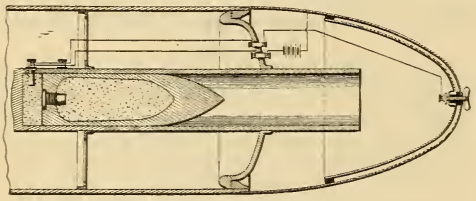
DYNAMO AND MOTOR ATTENDANTS AND THEIR MACHINES. (Fifth edition.) By Frank Broadbent. London: S. Rentell & Co., Ltd. 133 pages, with 66 illustrations.

This is a practical book for practical men, taking up such subjects as how to choose the right dynamo or motor for particular purposes, erecting machines, methods of driving, how to start, stop and parallel dynamos, speed control, faults and how to find them, etc. Some of the later types of apparatus are illustrated and there are also numerous diagrams helpful to the operator in running his machines.

NEW ELECTRICAL INVENTIONS.

ELECTRICALLY FIRED TORPEDO.

The torpedo shown in the cut is designed to be fired by electricity when it strikes the target, and the firing mechanism is all contained within the torpedo itself. A standard torpedo shell is represented, consisting of an outer shell with-



ELECTRICALLY FIRED TORPEDO.

in which is mounted the torpedo proper containing the explosive. The torpedo is ejected under the water from the usual firing tube.

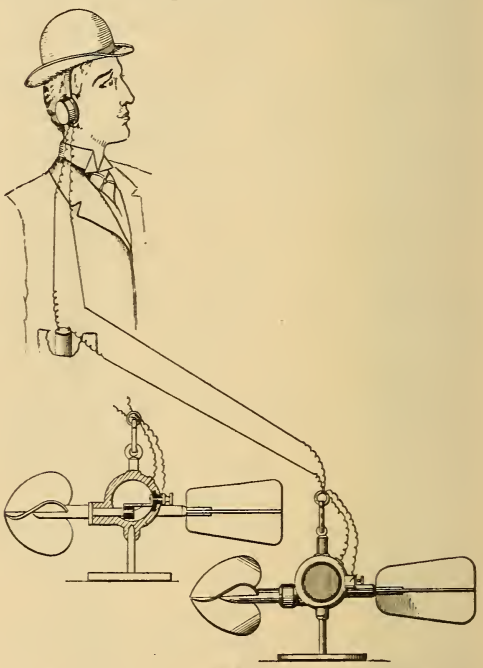
The nose of the torpedo is provided with an inner metallic casing which extends only a short distance back and is insulated from the outer casing. As the torpedo proceeds through the water, the little screw propeller seen at the forward end turns, and the threads on its shaft draw an electrical contact up until it touches the inner casing of the torpedo nose or war head as it is called. An electrical circuit is now complete through a battery and sparking arrangement with the exception that there is a break between the outer and inner casing of the warhead. When the torpedo strikes the target the metal casings of the warhead are jammed together, completing the circuit and firing the charge.

A point of advantage in the scheme is that there is no danger of premature discharge. The only way the circuit can be closed is by jamming the two casings together and at the same time having the screw contact, which is operated by the propeller, brought up against the inner casing. The latter is the case only after the torpedo is under way in the water and the propellor has performed its function.

The system is the invention of Lieutenant Commander Cleland Davis, United States Navy, Washington, D. C.

MEASURING THE VELOCITY OF WATER.

A simple electrical device for measuring the velocity of water current consists of a sort of revolving propeller blade held against the current by a rearwardly projecting vane. On the shaft is a make-and-break device which opens and closes a battery circuit a given number of times for each revolution. A telephone ear-piece with head-band for

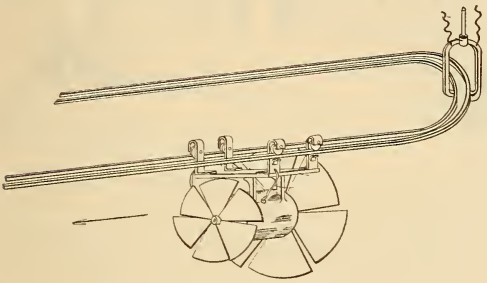


APPARATUS FOR MEASURING VELOCITY OF WATER.

the operator is also included in the circuit, so that with every closing of the circuit the operator hears a click in the receiver. He is thus enabled readily to count the number of revolutions of the shaft in a given length of time. The instrument has been previously calibrated so that it is known how many revolutions it will make in a minute when submerged in water flowing at various known velocities, so by a little calculation the operator can ascertain the velocity of the stream he is measuring. The inventor is J. S. J. Lallie of Denver, Colo.

TRAVELING FAN.

An inventor, Frank B. Thilow, of Philadelphia, has hit upon the idea that an electric fan may be made which will travel about a room expelling the impure air from every corner. The illustration shows his invention. A double fan with a motor between is suspended from wheels which run upon a little iron track. The rails of this track form the two main

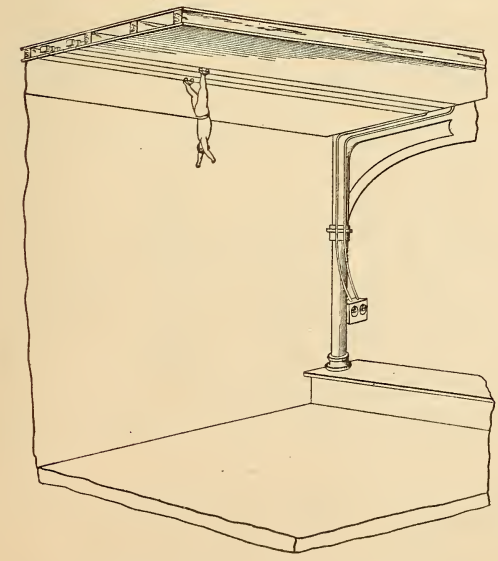


TRAVELING FAN.

conductors of the electric circuit from which the current is collected by a simple device and carried to the motor. When set in motion the larger fan presses against the air with sufficient force to send the whole device along the track, which is continuous.

WALKING ON THE CEILING.

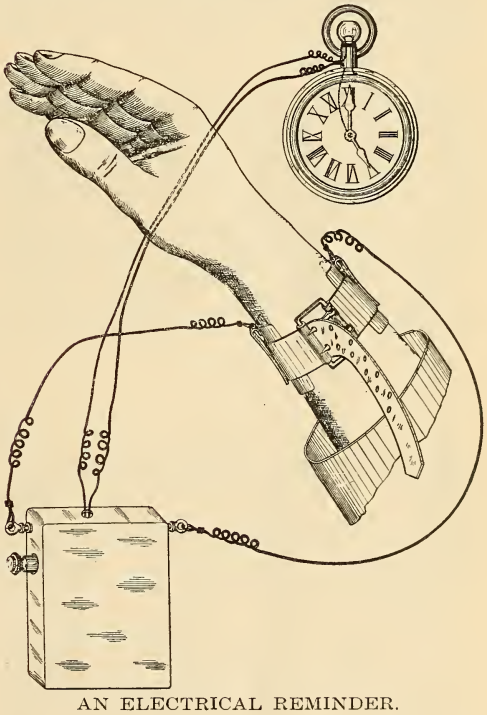
The accompanying diagram shows in a general way an arrangement to enable a person to walk, slide or skate in an inverted position on the under side of a ceiling. Its inventor, Ernest F. George of Manlius, N. Y., calls it an "electric aerial ambulating system." The scheme is to place a number of electromagnets in the ceiling, concealed from view, of course. They are arranged in parallel rows. These magnets are energized by wires carrying electric current. On the feet of the actor are skate-like appliances made of iron, which are attracted by the magnets.



WALKING ON THE CEILING.

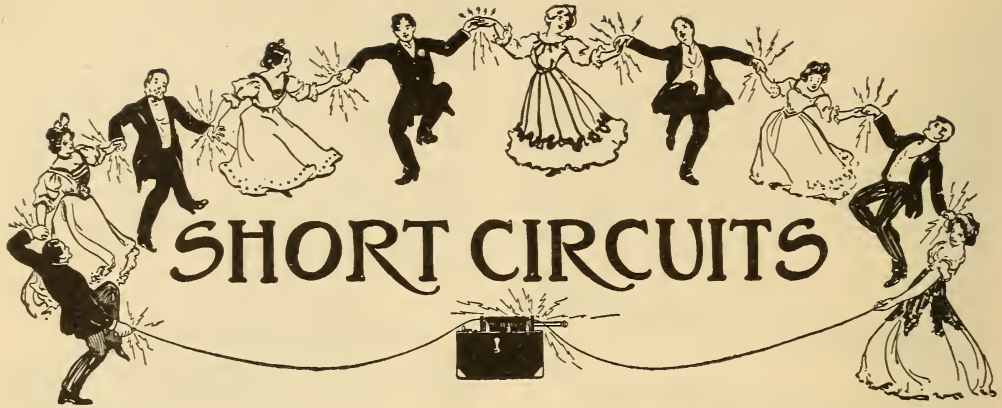
AN ELECTRIC REMINDER.

Most of us have had recourse at some time or other to the time-honored practice of tying a string around the finger to enable us to remember to do a certain thing at a certain time.



AN ELECTRICAL REMINDER.

A more elaborate device is shown in the illustration which is the invention of two citizens of Austria-Hungary. It consists of a battery and induction coil and a specially made watch. Wires from the secondary of the coil lead to electrodes strapped on each side of the wrist. The watch closes the circuit to the battery at any predetermined time, which starts the induction coil and gives the sleeper a "rousing" shock.



They were playing 500, when a very pompous lady bid eight on diamonds. "Have you any diamonds?" she said to her partner. "No," said her partner, a very little mild-tempered man, but added hastily, "I've got what you dig 'em with."

* * *

A gentleman and his wife, both of whom were greatly respected by their neighbors for their Christian charity, entertained a visiting clergyman from a distant city. Among the guests were members of their own church. A bright little daughter of the host was greatly interested in the good doctor, and very curious to know why people should say grace before eating. The doctor was pleased at the question, and hastened to inform her that all good people endeavored to return thanks in that manner for the good things which were given.

"Yes," exclaimed the little inquisitive, "but you don't say grace just like my papa said last night."

"How was that?"

"My God, what a supper!"

* * *

The teacher was giving a geography lesson, and the class, having traveled from London to Labrador, and from Thessaly to Timbuctoo, was thoroughly worn out.

"And now," said the teacher, "we come to Germany, that important country governed by the Kaiser. Tommy Jones, what is a Kaiser?"

"Please 'em," yawned Tommy Jones, "a stream of hot water springin' up an' disturbin' the earth!"

* * *

Once upon a time there were two prisoners in jail. One was in for stealing a cow; the other for stealing a watch. Exercising in the courtyard one morning, the first prisoner said, tauntingly, to the other: "What time is it?" "Milking time," was the retort.

* * *

Every family should have a curfew, says an exchange, which should "ring tonight" and all other nights if needed. These curfews are inexpensive and can be made at home. Take a piece of siding two feet long and whittle one end to a handle. Take the child that needs the curfew and bend it over a barrel. Now take the siding and use it as a clapper. Put it on hot, dividing the strokes evenly, and see that none misses. Good for a boy or girl up to 18, and three applications are warranted to cure the most pronounced case of street loafing that exists. The resulting music is said to be more effective than singing "Where Is My Wandering Boy Tonight?"

Englishman (in British Museum):—"This book was once owned by Cicero."

American Tourist:—"Pshaw! That's nothing. Why, in one of our American museums we have a lead pencil which Noah used to check off the animals as they came out of the Ark."

* * *

A ruralist in Missouri posted his lands—the notices reading as follows:

"Notis—Trespaser will be persekuted to the full exten of 2 mean mungrel dogs wich ain't never ben overly soshibil with strangers an' I dubbelp barl shot gun wich ain't loaded with no sofy pillers dam if I ain't tire of this helraisin' on my property."

* * *

Professor (to his aged cook)—"You have now been twenty-five years in my service, Regina. As a reward for your faithfulness I have decided to name the bug I recently discovered after you."—Meggendorf Blaetter.

* * *

"What became of Pat?"

"He was drowned."

"And couldn't he swim?"

"He did for eight hours, but he was a union man."

* * *

Matrimonial Catechism.—What is marriage? Marriage is an institution for the blind.

Should a man marry a girl for money? No. But he should not let her be an old maid just because she's rich.

When a girl refers to a "sad courtship," what does she mean? She means that the man got away.

Is an engagement as good as a marriage? It's better.

When asking papa, how should a young man act? He should face papa manfully, and never give him a chance at his back.

When the minister says, "Do you take this woman for better or for worse?" what does he mean? The bridegroom's people construe it one way, and the bride's family interpret it another. It is very sad.

When a man says he can manage his wife, what does he mean? He means he can make her do anything she wants to.

When a child is smart and good, to whose family is it due? To its mother's.—Chicago Medical Recorder.

* * *

"You are charged with stealing nine of Colonel Henry's hens last night. Have you any witnesses?" asked the justice sternly.

"Nussah!" said Brother Jones humbly. "I 'specks I's sawtuh peculiar dat-uh-way, but it ain't never been mah custom to take witnesses along when I goes out chicken-stealin', suh."

HAD THE ANCIENT EGYPTIANS UNDERSTOOD ELECTRICITY.

ELECTRICAL DEFINITIONS.

Accumulator.—Storage battery.

Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.

Ammeter.—An instrument for measuring electric current.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt.

Ampere Hour.—Quantity of electricity passed by a current of one ampere flowing for one hour.

Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.

Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.

Branch Conductor.—A parallel or shunt conductor.

Brush.—The collector on a dynamo or motor which slides over the commutator or collector rings.

Bus Bars.—The heavy copper bars to which dynamo leads are connected and to which the out-going lines, measuring instruments, etc., are connected.

Buzzer.—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.

Candle Power.—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.

Capacity, Electric.—Relative ability of a conductor or system to retain an electric charge.

Charge.—The quantity of electricity present on the surface of a body or conductor.

Choking Coil.—Coil of high self-inductance.

Circuit.—Conducting path for electric current.

Circuit-breaker.—Apparatus for automatically opening a circuit.

Collector Rings.—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.

Commutator.—A device for changing the direction of electric currents.

Condenser.—Apparatus for storing up electrostatic charges.

Cut-out.—Appliance for removing any apparatus from a circuit.

Cycle.—Full period of alternation of an alternating current circuit.

Diamagnetic.—Having a magnetic permeability inferior to that of air.

Dielectric.—A non-conductor.

Dimmer.—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.

Direct Current.—Current flowing continuously in one direction.

Dry Battery.—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.

Electrode.—Terminal of an open electric circuit.

Electromotive Force.—Potential difference causing current to flow.

Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.

Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.

Electroscope.—Instrument for detecting the presence of an electric charge.

Farad.—Unit of electric capacity.

Feeder.—A copper lead from a central station to some center of distribution.

Field of Force.—The space in the neighborhood of an attracting or repelling mass or system.

Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.

Galvanometer.—Instrument for measuring current strength.

Generator.—A dynamo.

Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.

Insulator.—Any substance impervious to the passage of electricity.

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

Leyden Jar.—Form of static condenser which will store up static electricity.

Lightning Arrester.—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.

Motor-dynamo.—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.

Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.

Multiple Circuits.—See parallel circuits.

Neutral Wire.—Central wire in a three-wire distribution system.

Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in height.

Parallel Circuits.—Two or more conductors starting at a common point and ending at another common point.

Polarization.—The depriving of a voltaic cell of its proper electromotive force.

Potential.—Voltage.

Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.

Rheostat.—Resistance device for regulating the strength of current.

Rotary Converter. — Machine for changing high-potential current to low potential or vice versa.

Secondary Battery.—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.

Self-inductance.—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.

Series.—Arranged in succession, as opposed to parallel or multiple arrangement.

Series Motor.—Motor whose field windings are in series with the armature.

Shunt.—A by-path in a circuit which is in parallel with the main circuit.

Shunt Motor.—Motor whose field windings are in parallel or shunt with the armature.

Solenoid.—An electrical conductor wound in a spiral and forming a tube.

Spark-gap.—Space between the two electrodes of an electric resonator.

Storage Battery.—See secondary battery.

Thermostat.—Instrument which, when heated, closes an electric circuit.

Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

Volt.—Unit of electromotive force or potential. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

Voltage.—Potential difference or electromotive force.

Volt Meter.—Instrument for measuring voltage.

Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.

Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.

HOW THE PRESIDENT SAVES AN HOUR EVERY DAY

A NEW SYSTEM WHICH ECONOMIZES THE TIME OF THE OFFICERS OF THE COMPANY AS WELL AS THE MANAGERS AND CLERKS.

LIKE most other men with Hurry as their gad-fly, I sometimes hear of astonishing things that I mean to look into, but which "business" drives out of my mind before I have the opportunity to investigate. But when I was told at luncheon the other day that the active President of a great corporation had installed a system whereby he could instantly and directly issue a general order to all the heads of departments throughout the building, at one time without leaving his room, I remembered to have heard about that wizard-like performance before, and determined to follow the lead at once, before I could lose it again. Fortunately I was acquainted with the President, and I found him not only willing but rather pleased to show me the operation of the wonderful saver of time and annoyance.

Just under the pigeon-holes of his desk, out of the way of everything and almost out of sight, was set an innocent looking box not more than 11 inches long and 6 inches high; a row of small levers ran along the lower part of it, above which were two orifices that might remind one of a pair of exaggerated eyes.

"Demonstration number one," said the President, and reaching over he pulled down several levers; "Buzz," went the instrument and several "buzzes" answered. "Now I know," said he, "that my heads of departments are at their end of the wire and I'm going to issue a general order about deliveries," which he did in a low tone of voice at a distance of at least 6 feet from the box, and rather away from it than toward it. "Is that understood, Mr. Evans, Mr. White, etc.?" and he went down the line of names. Imagine my astonishment when "Yes, sir, O. K.," came from the box, as each name was called in tones clearly audible in every part of the private office (about 15 feet square). It was almost uncanny.

"You see," he said, "instead of sending a boy and bringing them to my office from distances of 100 to 700 feet and on different floors, I can issue a general order and have it acknowledged in 10 seconds.

"Demonstration number two will show you how the private office can be secluded even from my stenographer who used to be its most consistent invader," continued the President, as he pressed another lever; instantly the box said, "Yes, sir, ready"—walking to the extreme end of the office he dictated a letter in a tone of voice scarcely above a whisper and, mind you, without connection with or apparent regard for the location of the box—talking into the air. "Read that back, please," and out of the instrument came the text of the letter word for word clearly understandable and distinct to both of us.

"This feature is particularly desirable," he said, "when I have a number of gentlemen in the office and want to dictate an agreement or a letter. It saves the time for them and for me which would be required for her to come to the office and depart; I get her instantly and when through dictating I shut off and we are immediately ready to resume our conference."

"The third demonstration will show you how secret communication is assured. We will assume that you are a salesman and have quoted me a price on a large quantity of oil. I press my bookeeper's lever," suiting the action to the word, "and ask 'What did we pay for that last supply of oil?' Now I take this receiver off the hook; that automatically causes the instrument to act like an ordinary telephone—I get the information and you have heard nothing. Further

and entire secrecy is assured by the fact that no matter how many lines are opened on the other end (or substation), nothing can be heard unless I switch them on here (at the master-station). No central is necessary—the inter-communicating and cutting out system is evidently perfect in its arrangement and is entirely governed by my pressing the lever."

"Here is also an interesting test that I have tried. We will suppose that clerk No. 1 has laid the blame for an error on clerk No. 2, I connect up both clerks without either knowing that the other is on the wire; then I say to clerk No. 2, 'Clerk No. 1 says that you are at fault in this case,' and state the reason. Clerk No. 2 gives his side and if it is not correct Clerk No. 1 breaks in and tells him so. They then argue it and I hear both sides without taking them away from their desks or having them invade my office for the discussion.

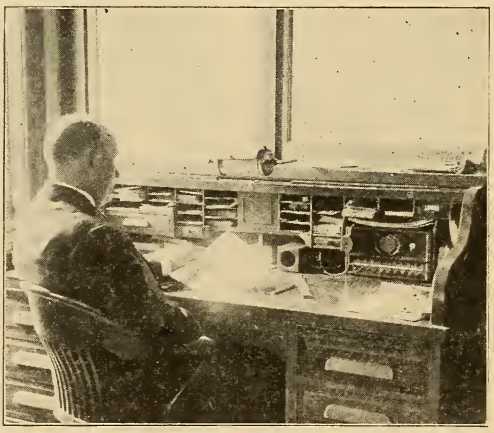
"It is quite a detective in its way and beside giving me much inside information I figure that it saves me perhaps as much as one to two hours a day, which is obviously a great consideration.

"Our Secretary, Treasurer, General Manager and Superindentent, all have Master Stations and we can communicate with each other constantly without leaving our desks and without the bother of either talking into a mouthpiece or holding a receiver to the ear."

"Does it ever get out of order?" I asked.

"Ours has not as yet and it has been installed six months," was the reply. "It is put in on a rental basis and The National Dictograph Company guarantees all maintenance and perfect working order."

By the way, the name of this little Wizard of modern business is the Dictograph, but that name hardly expresses its capabilities as demonstrated to me, and in fact it would be hard to find a name that would.



President of large corporation dictating to his stenographer through the Dictograph.

I have just learned of another very interesting and practical service which the Dictograph rendered. A certain financial institution of large interests, through being checkmated in several important moves, was convinced that some of its employes were not only "leaking" but playing with the other side.

Suspicious actions led the officers of the Institution to believe that one room was consistently used for conferences by the employes in question—in this room they proceeded to install a Dictograph, setting it in the wall and covering it with wall paper so as to make it entirely invisible.

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Further investigation gives me the information that while the National Dictograph Company is a young concern, its instruments are now installed in some of the largest and most conservative Banks, Trust and Life Insurance Companies Industrial Corporations in New York and Chicago.

The purpose of the Company, now that the practicability and usefulness of the Dictograph has been proved by actual rentals to great Corporations, is to take immediate steps toward making it universally known and used.

It would seem that every business man would conserve his best interests by writing to the Sterling Debenture Corporation, 225 Fifth Ave., New York, for Booklet No. "N 381," which gives full information about the Dictograph, its purposes, its rentals, installations and plans for the future.

By W. W. Griffith.

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THE NEW SILICON DETECTOR will increase your receiving radius 500%. Only type sold to experimenters authorized by owners of Silicon patents. Infringers prosecuted! Send for special price list. W. C. Getz, 345 N. Charles St., Baltimore, Md.

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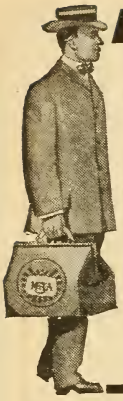

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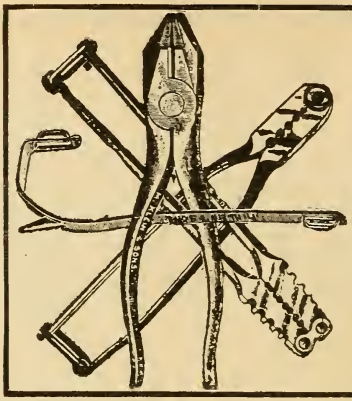

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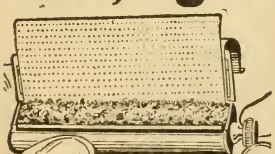

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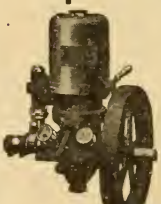

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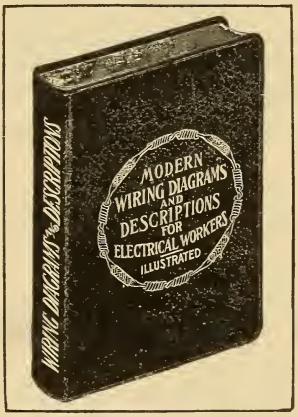
$ 

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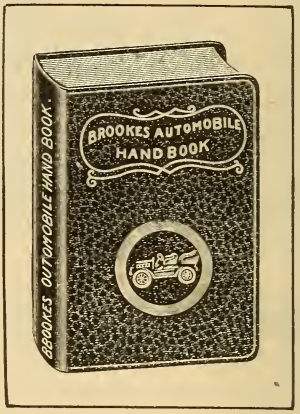
$ 

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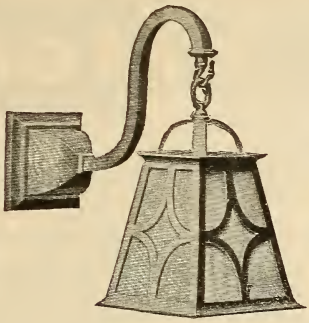

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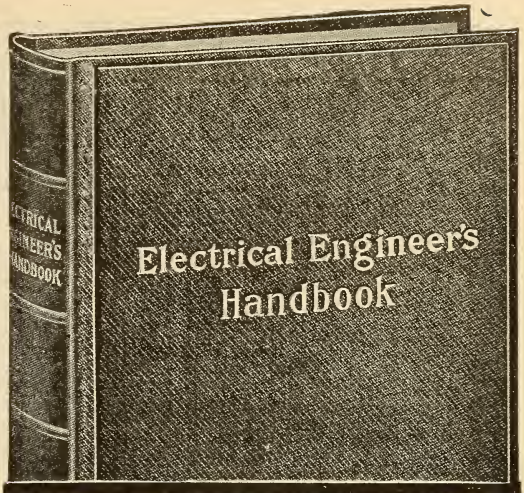

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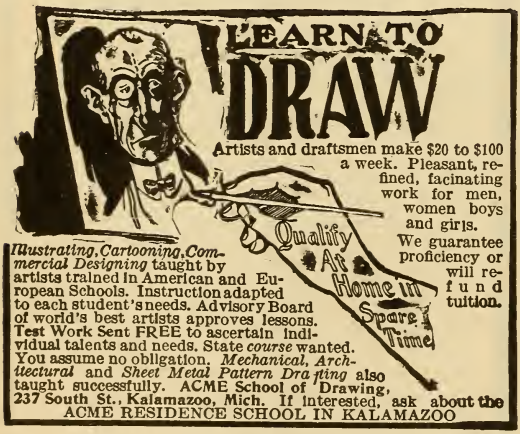

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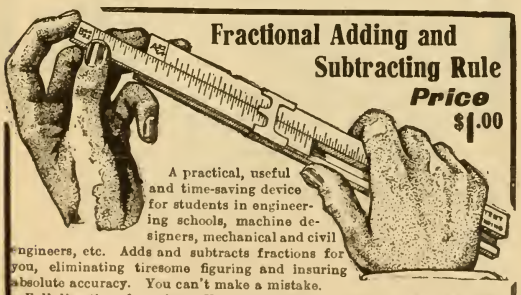

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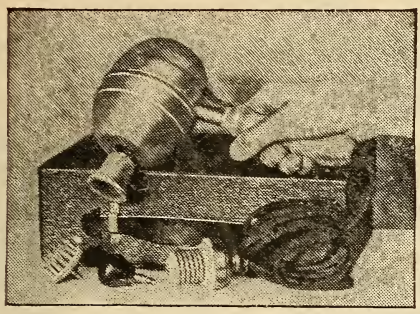

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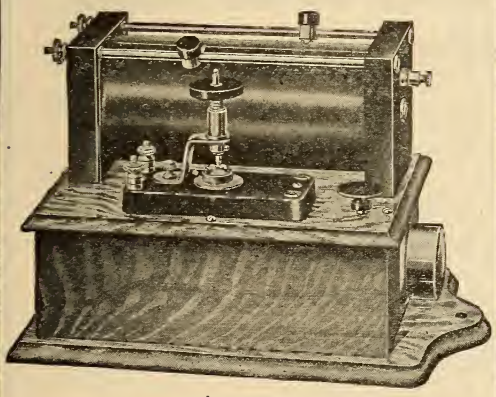

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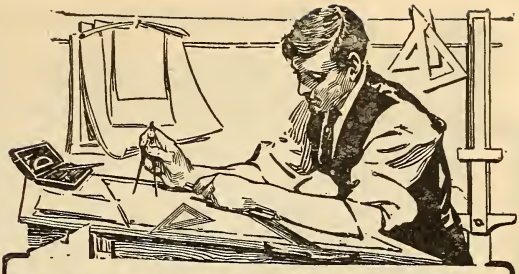

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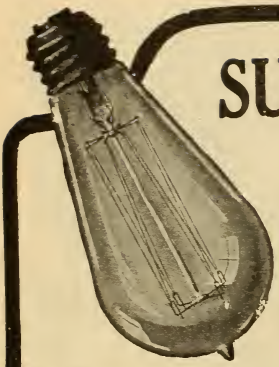

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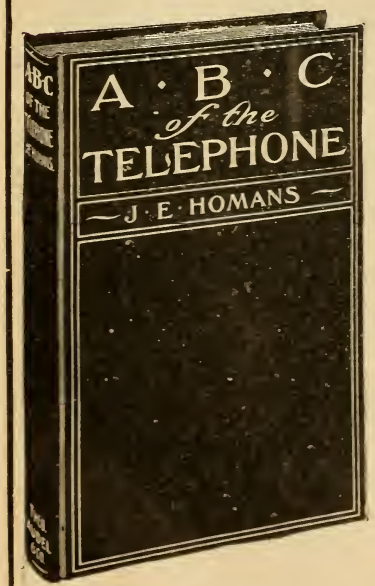

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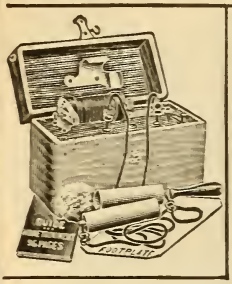

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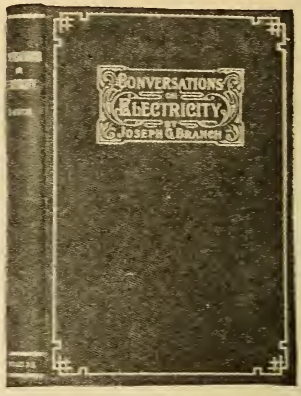

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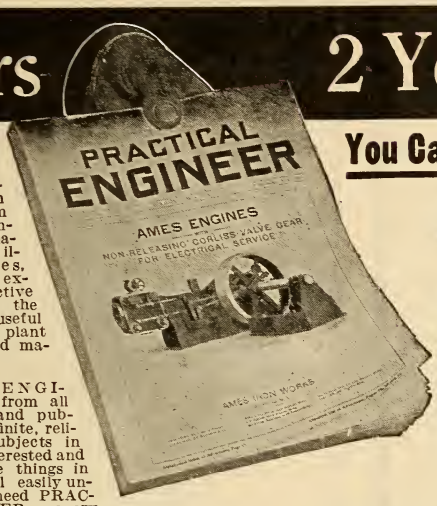

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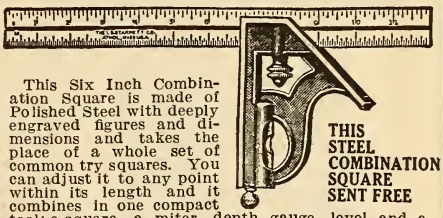

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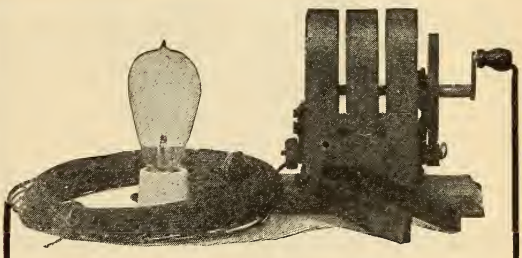

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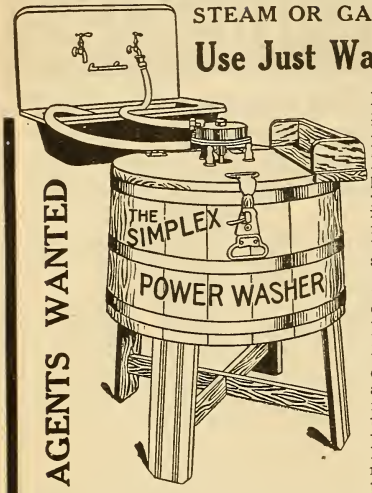

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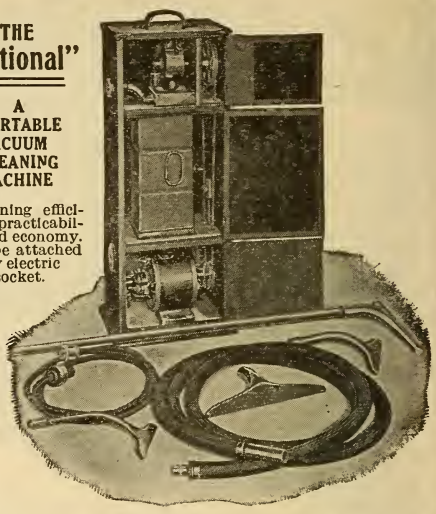

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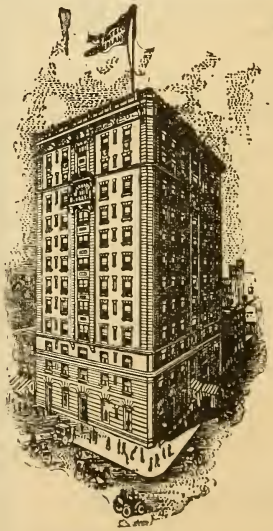

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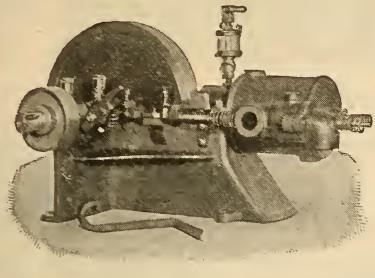

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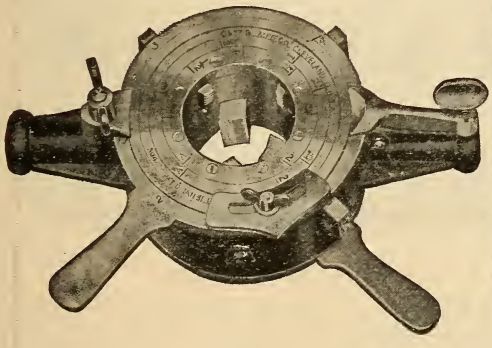

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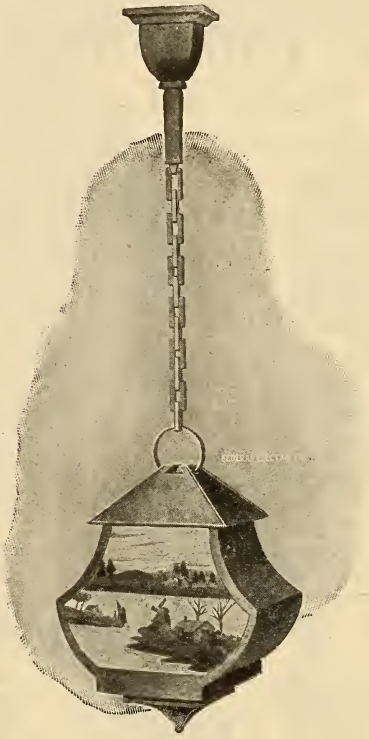

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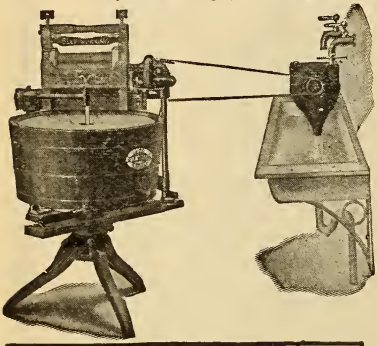

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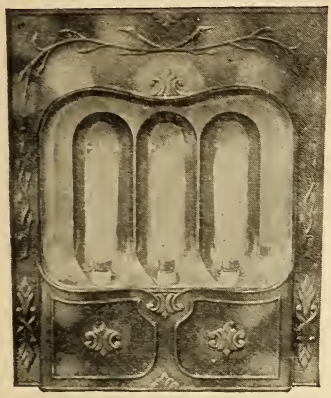

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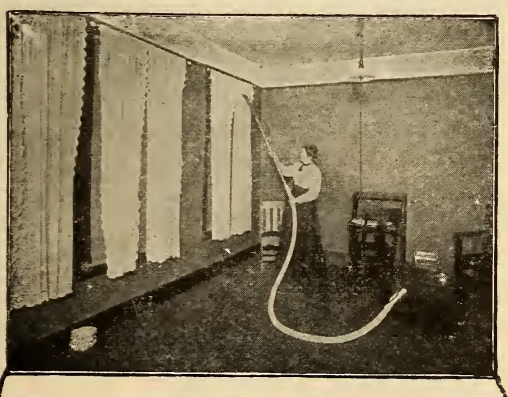

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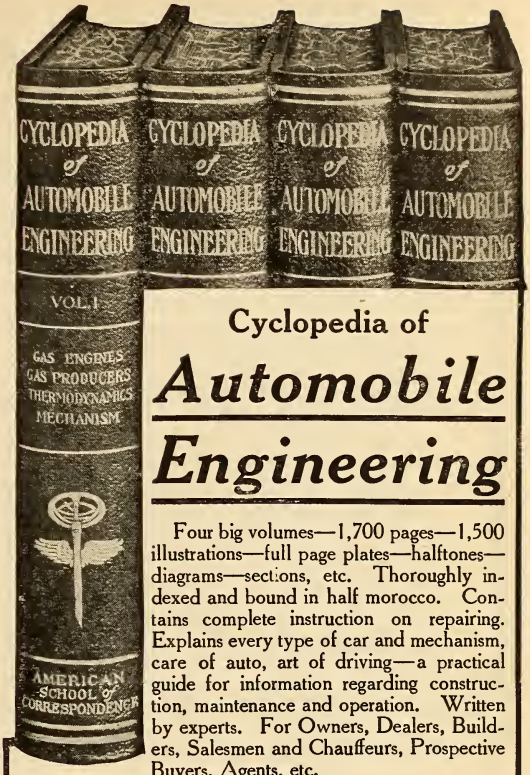
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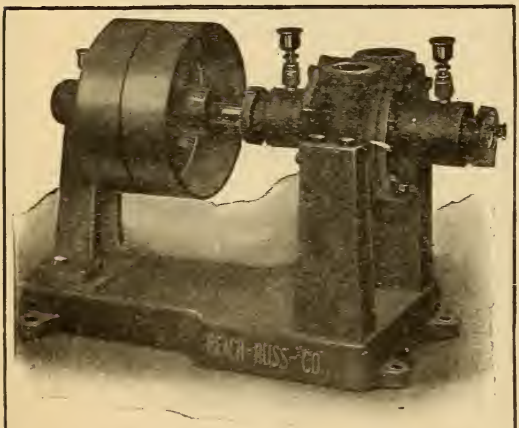

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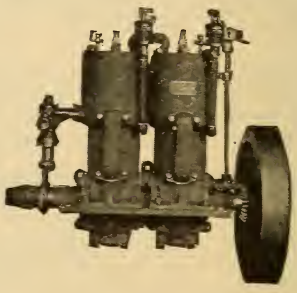

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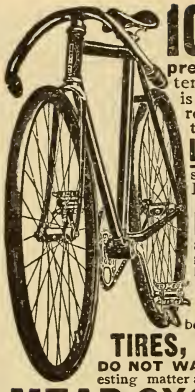

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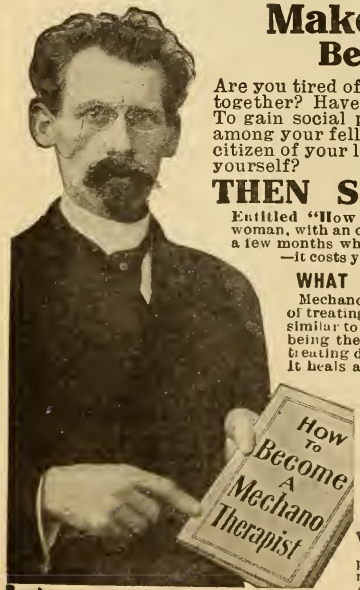

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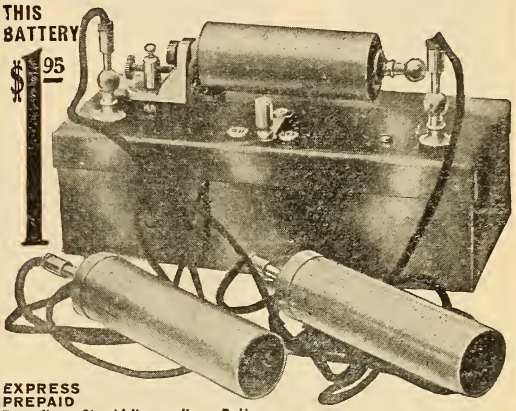

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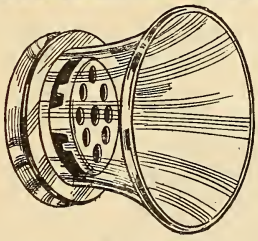

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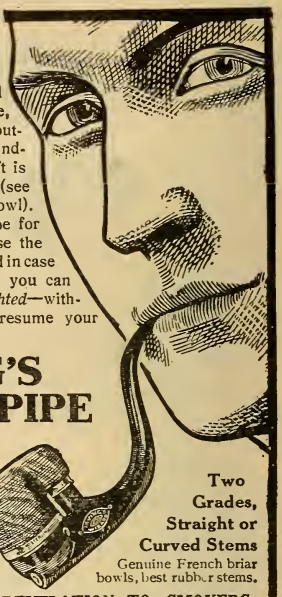

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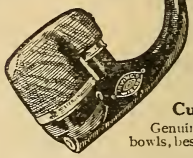

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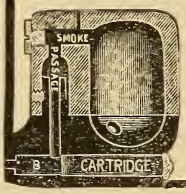

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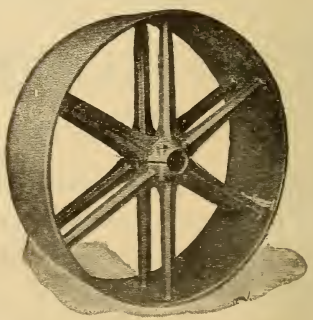

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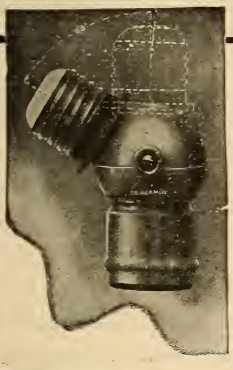

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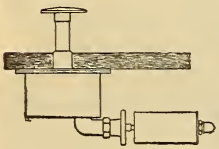

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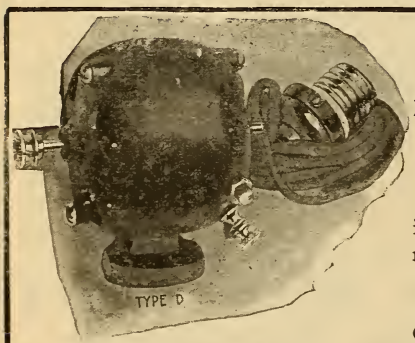

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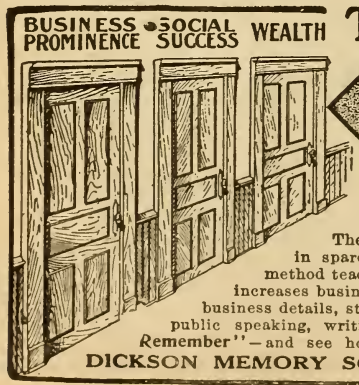

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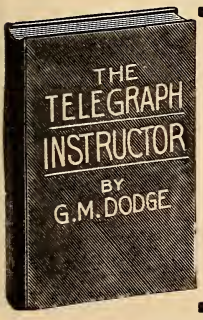

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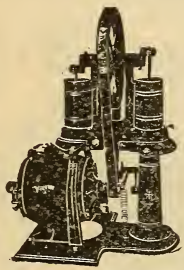

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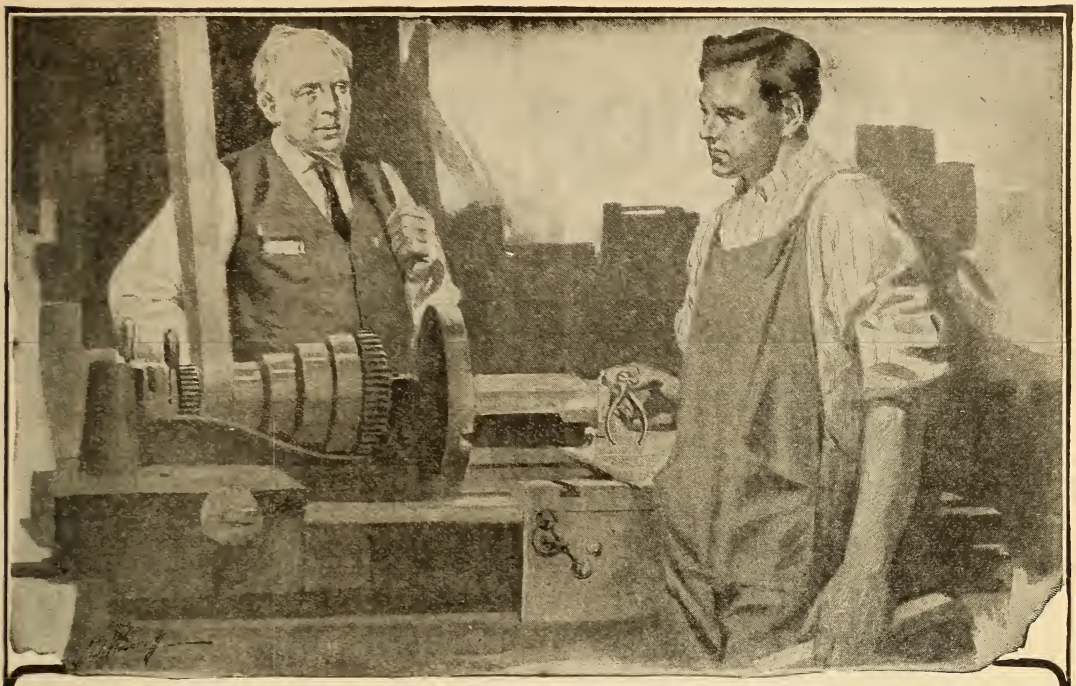

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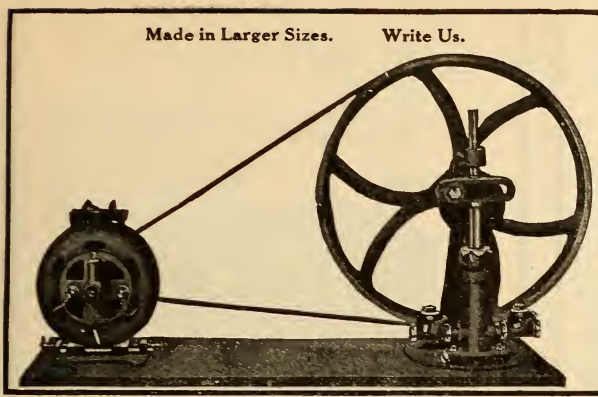

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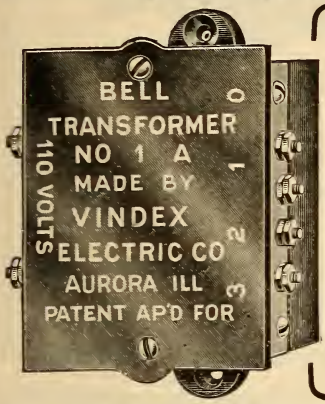

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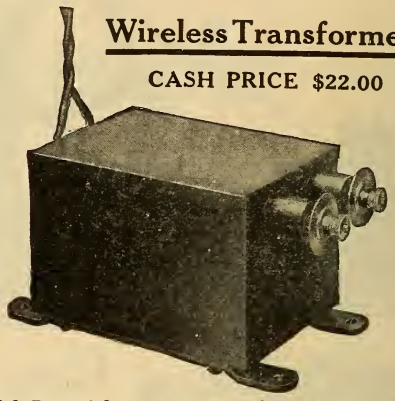

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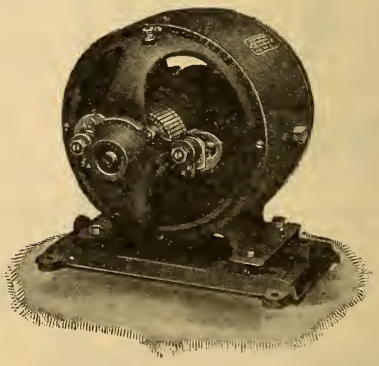

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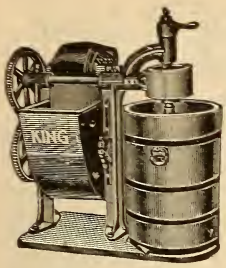

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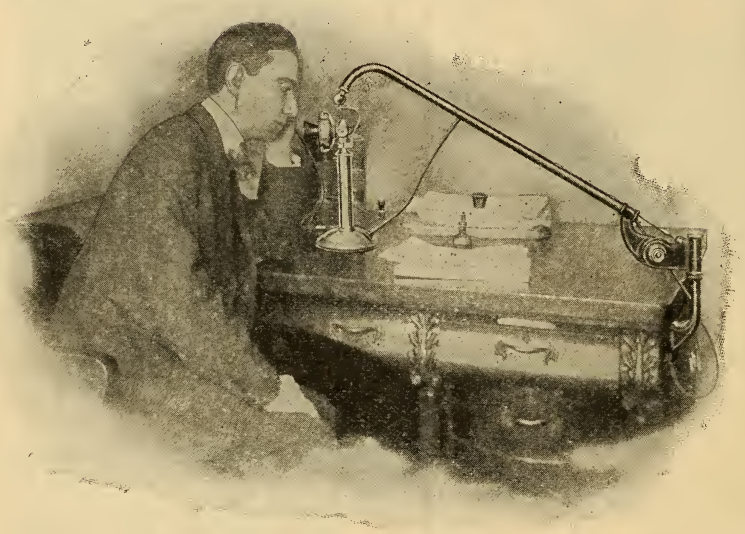

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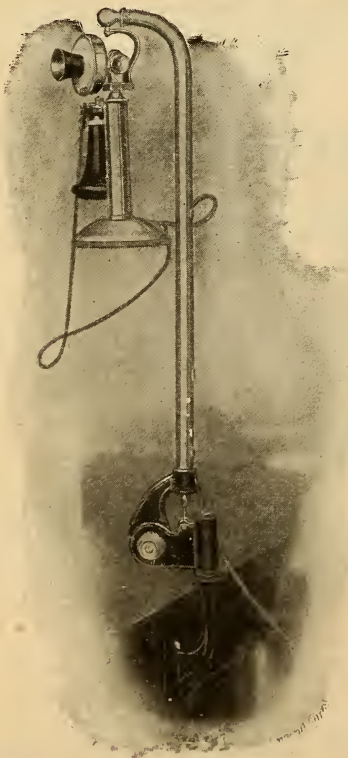

Radio Adjustable Telephone Holder.

The RADIO normally holds the telephone proper in a vertical position, yet by an ingenious device the user can tilt it so that the position suits his convenience while using; when released, it automatically resumes its normal or vertical position, the arm remaining at angle desired.

The RADIO makes a wall telephone and a desk telephone one.

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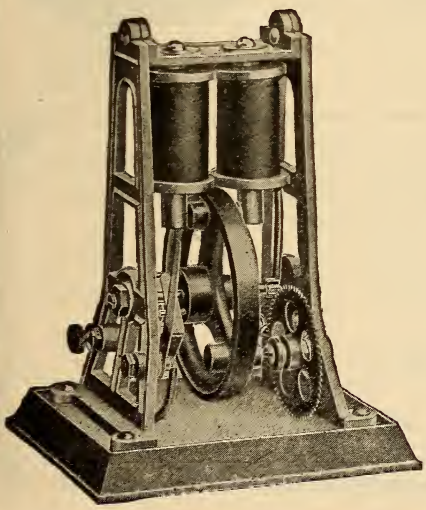

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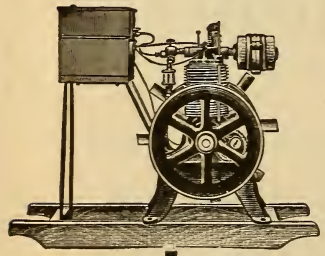

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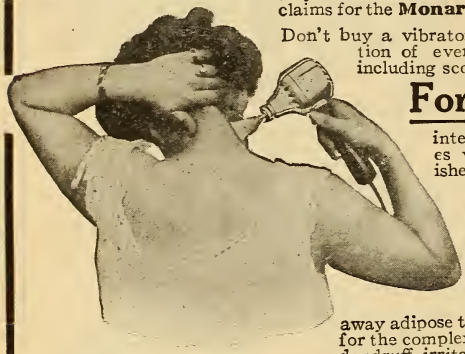

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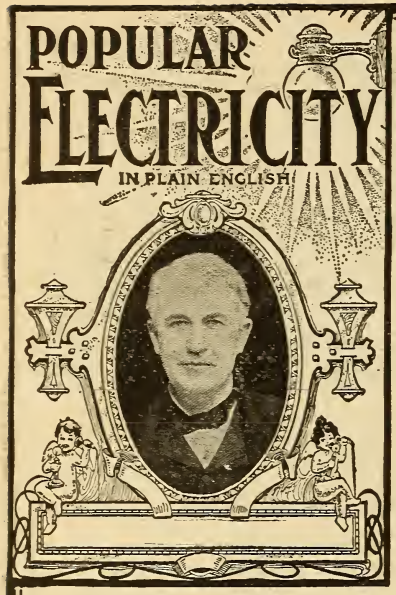

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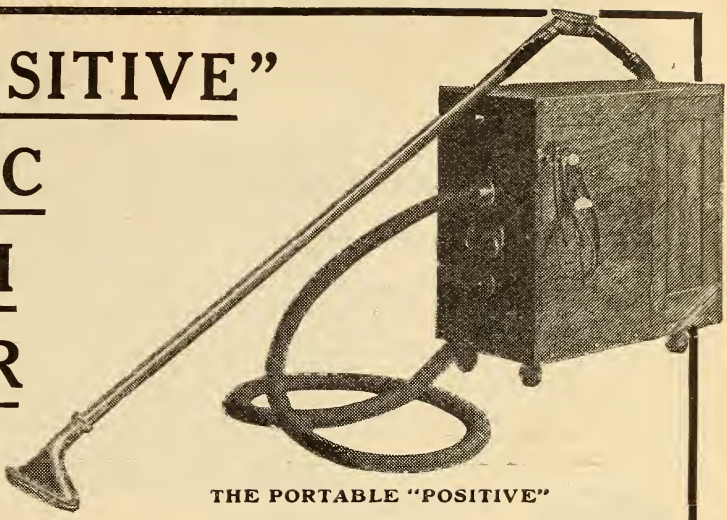

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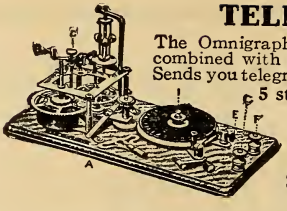

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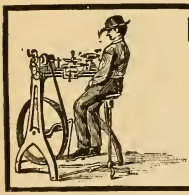

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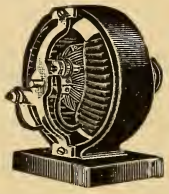

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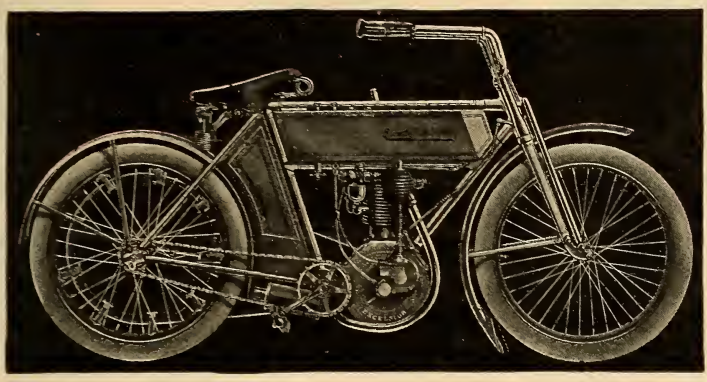

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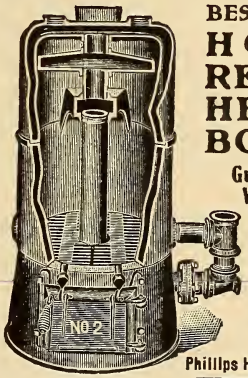

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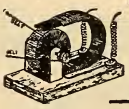

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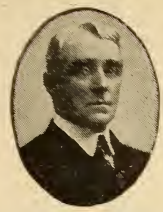

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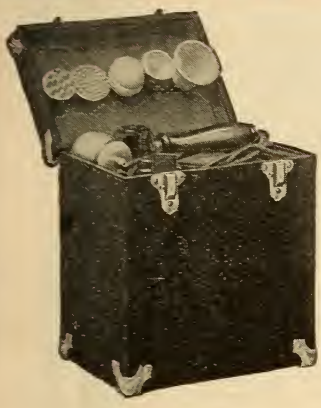

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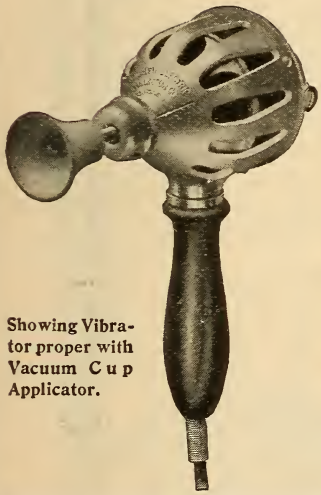
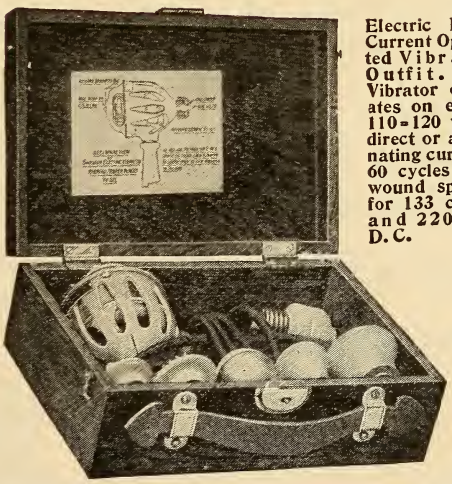


Showing Vibrator proper with Vacuum Cup Applicator.



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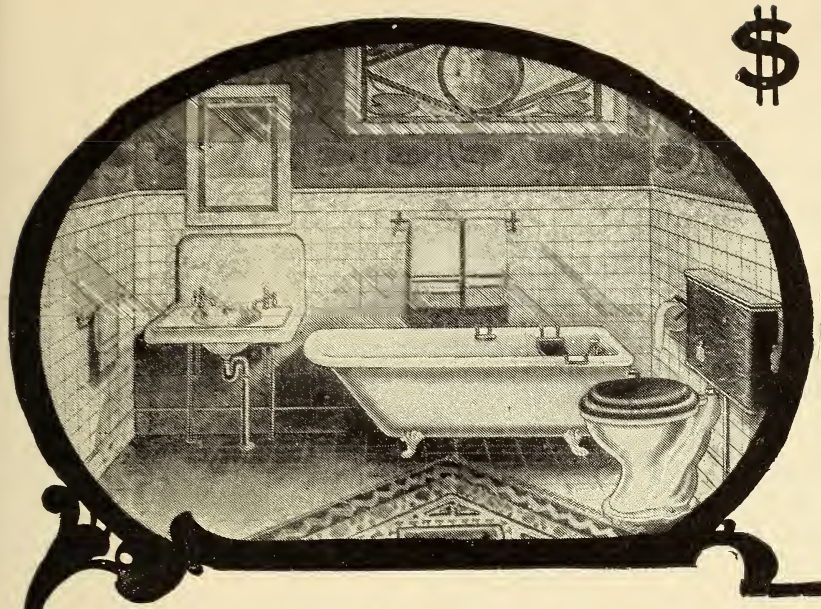

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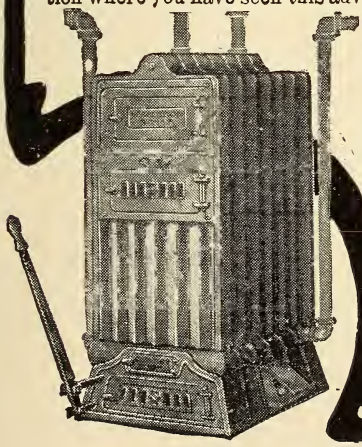

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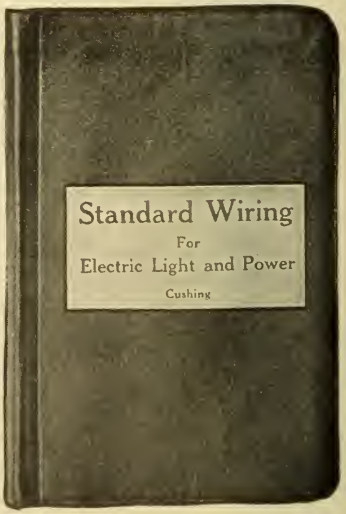

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Fig. 2

Fig. 3

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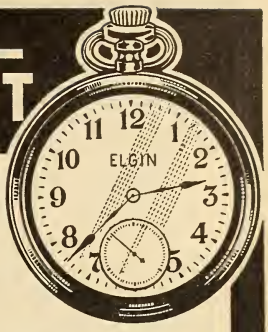

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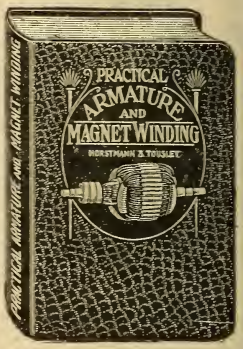

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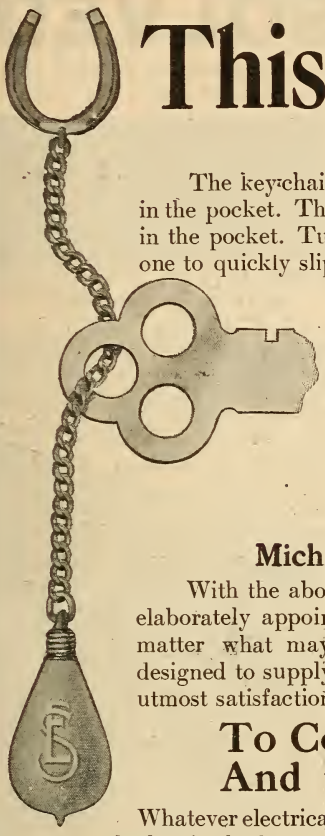

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THERE IS NO MYSTERY about the pipe work for plumbing. Look at the picture. The large vertical pipe is the stack. The smaller vertical pipe is the vent. All fixtures are trapped to prevent odor or sewer gas escaping into the rooms, and are so connected as to be properly vented. This is a fair type of Sanitary installation. We will arrange any variations for you to supply you the most perfect arrangement for your home. Whether in the city, where you have running water and sewerage, or in the country, where you have to provide your own water system and dispose of your own sewerage, you can have these improvements. We will sell you all the materials of all kinds needed, make you working drawings, and tell you how to do the work.

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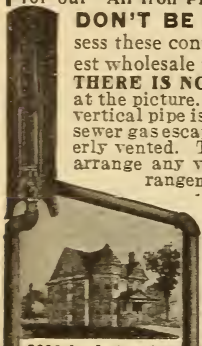

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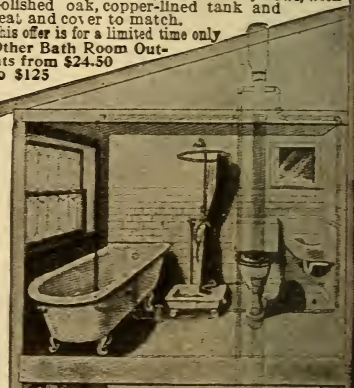

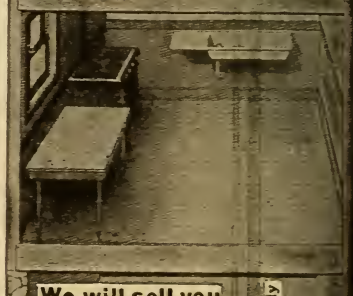

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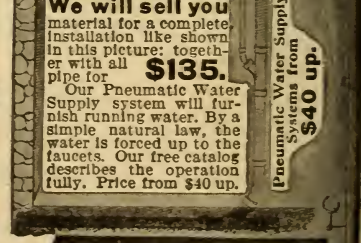

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POPULAR ELECTRICITY

IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. II JULY, 1909 No. 3

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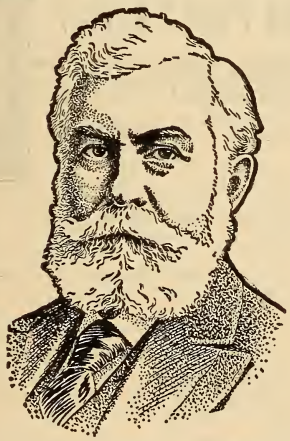

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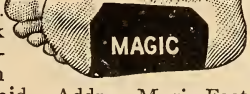

My Dear Sir:

(And this is addressed to the gentleman who is now reading it.)

A man who is an acknowledged authority in the cigar business, recently said to a friend of mine: *"Shiver's Panetela Cigar is a good cigar—better than I expected, and for the life of me I don't see how it can be sold for the money."*

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If I had to hunt up a new customer every time I make a sale it would put me out of business in a month, but re-orders, not once, but repeatedly, I must have and do receive in continually growing volume.

The result is I have built up a constantly increasing patronage. Incidentally I have sufficient standing orders for cigars, to be shipped on stated days of the month as they come around, to keep a small factory busy.

Every cigar that I make is sold direct to the consumer in lots of a hundred or more at wholesale prices (there are no discounts to dealers or clubs, nor for any quantity), and is shipped from the factory in the best of condition without any rehandling.

I manufacture every cigar that I sell, consequently *know* exactly what is in them.

In do not retail cigars nor sell sample lots. It costs more to do so than to ship the original package, and in addition, one or two cigars is not a real test. Moreover, I might be charged with sending samples better than the goods prove to be. I ask smokers to give the actual cigars a fair trial, and if they are not pleased, to return the remainder. I cannot afford to have any one displeased.

My theory at the start was that most men know and appreciate cigar values, and that they would sufficiently appreciate the difference between retail and wholesale cigar prices to go to the trouble of ordering cigars from me could I once induce them to give the cigars a fair trial. To get them tried—to get *you* to try them—is why I make my offer so broad and so liberal. What risk can *you* assume, provided, of course, that $5.00 per hundred is not more than you care to pay?

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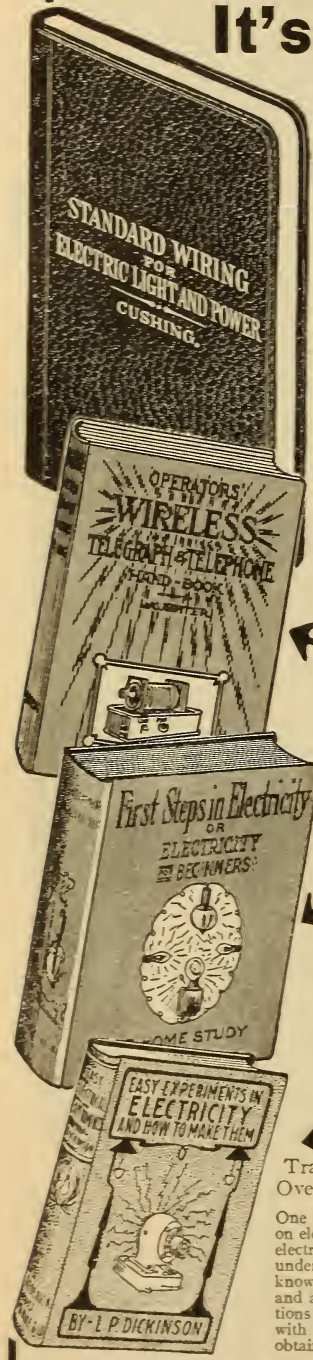
To Read This Carefully



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"SAY WHEN" the toast gets brown and crisp enough to suit your taste, then remove the slices.

Most toast is made by guess—not toasted enough, baked hard or burned to a crisp, according to luck, because the toasting process cannot be watched. With the new General Electric Radiant Toaster this uncertain element of **LUCK** is removed and the vertical slices of toasting bread can be watched and removed the very instant they suit your own personal taste.

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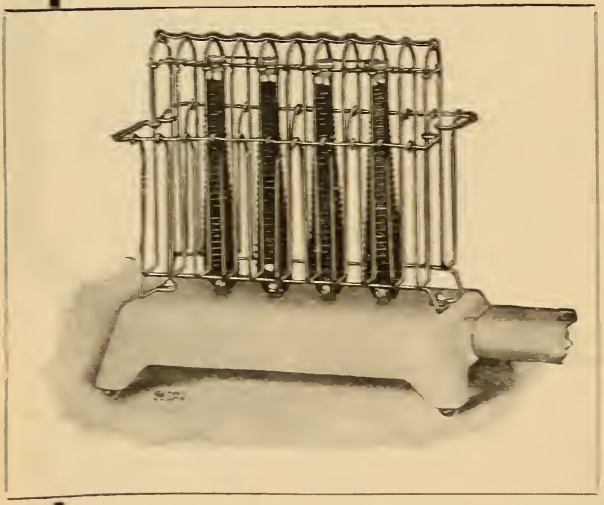

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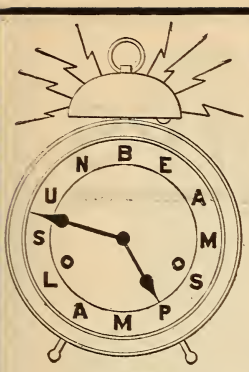

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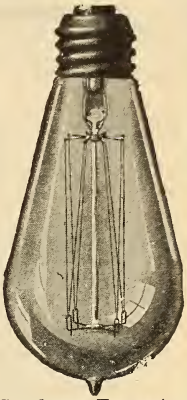

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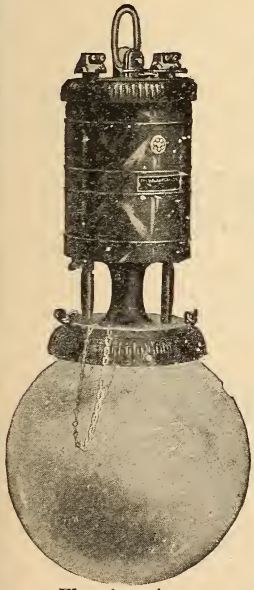

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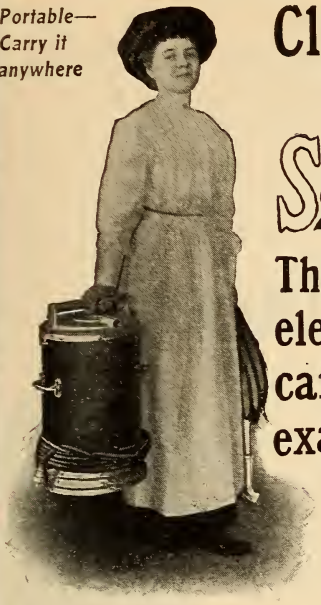

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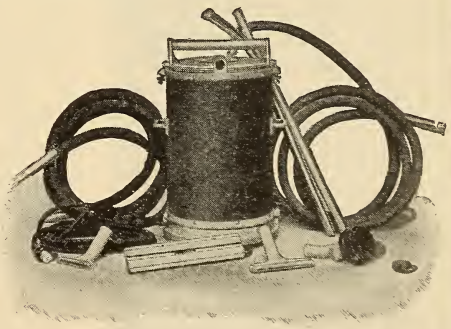

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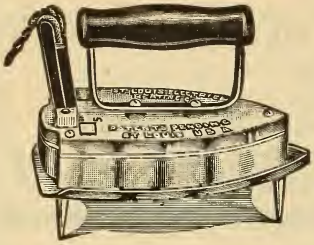

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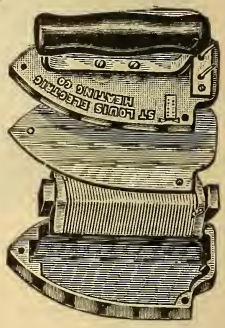

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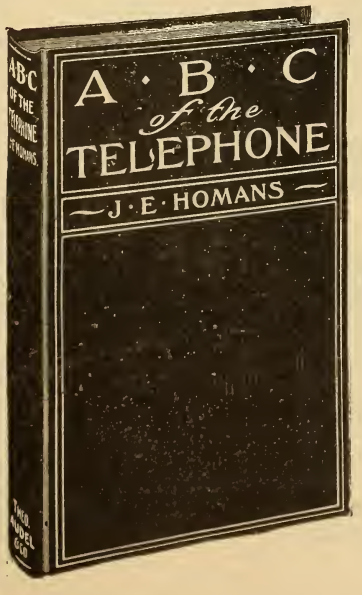

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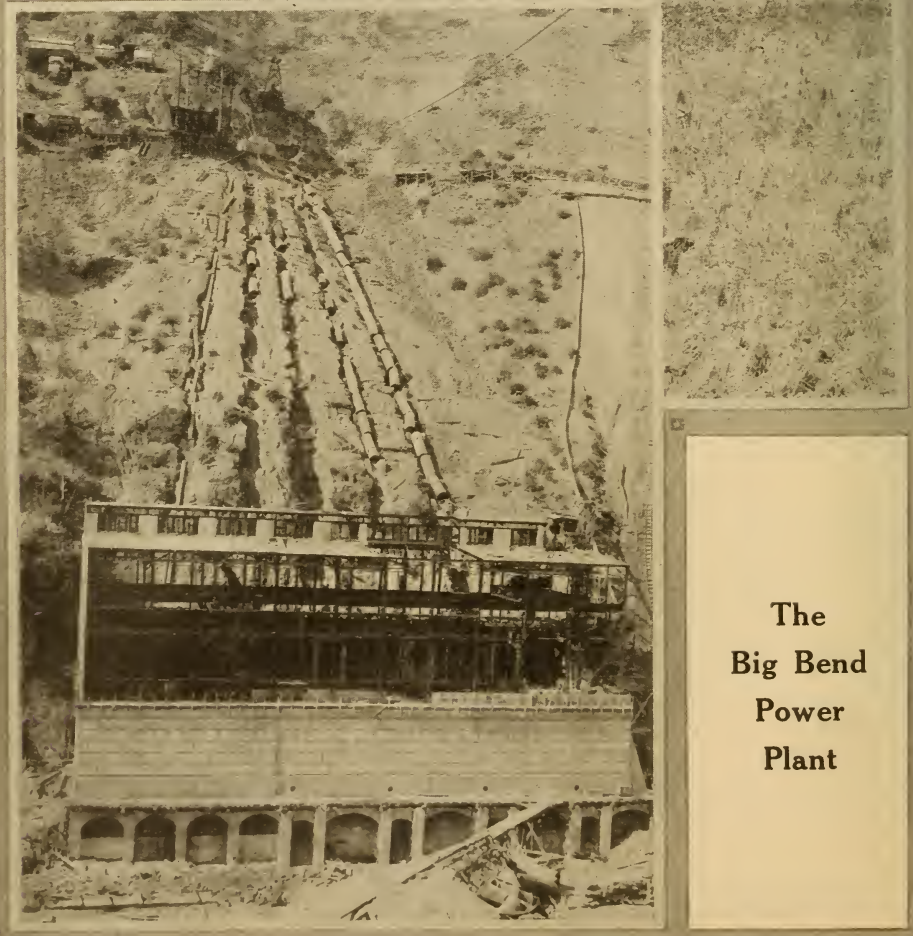

The Big Bend Power Plant

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POPULAR ELECTRICITY
IN PLAIN ENGLISH

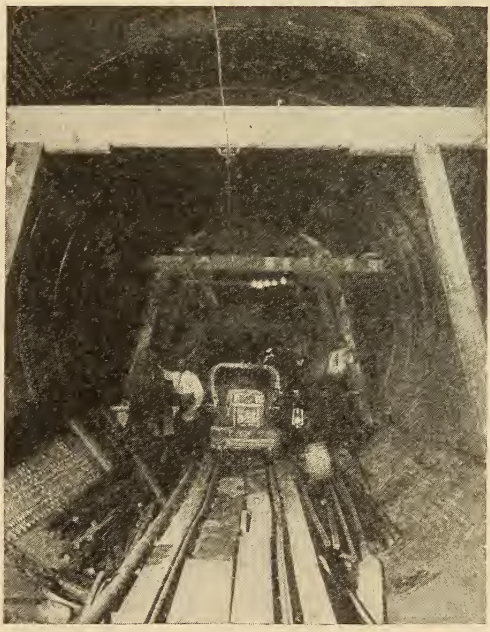
VOL. II JULY 1909 No. 3

CALIFORNIA'S GREAT POWER PLANT

BY DODD CURTIS.

Up among the foothills of the Sierras in Butte County, Cal., the fierce little Feather River tears its way for miles through canons and gorges, only to emerge at length but a short distance away from the point where it started in to encircle a mountain.

On a topographical map this loop of the river takes the form of a huge horseshoe, and is known as the Big Bend. And just here, at the neck of the Big Bend, is nearing completion a work that promises to revolutionize the future of vast tracts of country spread out over hundreds of miles between it and the sea. The movements of a far-reaching network of railways, the lighting of cities, the motive power to drive the machinery in great ship building plants, and textile manufactories; all these and more, will be controlled by a set of tiny buttons in the switchboard gallery of the power house of the Great Western Power Company at Big Bend.



DRIVING THE WATER POWER TUNNEL

Briefly told, this is accomplished first of all by means of a huge dam at one side of the Big Bend, which backs the waters in the Feather River up to a great intake tower. Here the river enters a tunnel three miles long, driven through the heart of the mountain to the other side of the Big Bend, a gradual fall of 75 feet. At the outlet of the tunnel the water drops over 300 feet, through four large pipes directly to the turbines in the power house below on the edge of the river. These turbines are the largest and most powerful water wheels yet constructed, and the tunnel is the longest water power tunnel in the world.

Within the power house, from each of the turbines, rise gigantic shafts upon which rest the dynamos, which in turn are connected to the transformers, and from the transformers lead out the transmission lines, first to the top of the mountain over the portal of the tunnel, thence by a succession of tall steel towers, down in a direct line, over hills and valleys, through cities and towns, vineyards and wheat fields to the sub-station in the city of Oakland.

The idea of a tunnel across the neck of the Big Bend is not new. In fact when the preliminary survey was made for the

Great Western Power Company, the mountain was already pierced by a small tunnel which had been cut through many years before for the purpose of draining the Feather River in the Big Bend for gold. The man who originated this scheme was a mining engineer named McLaughlan, and another man, Dr. Ira S. Pierce, agreed to furnish the money. About that time the latter patented a medicine which was very

SWINGING A BOILER ACROSS THE RIVER

largely advertised. With each bottle of medicine sold went a stock certificate in the Big Bend Mining Company. The medicine had a great vogue all over the country, and the funds to finance the tunnel project were raised without difficulty, but when the work was accomplished and the bed of the river laid bare, the miners discovered the abandoned tools—shovels, wheelbarrows, rockers and pans—of the Argonauts, whose work had long been forgotten.

So the tunnel remained unused until purchased by the Great Western Power Company, and while the initial expense went for naught, the work is amply paid for in this electrical development. With this nucleus of the small tunnel, the work of driving a new tunnel elbow about half as long again, went forward very rapidly, together with the work of enlarging the old tunnel to about three times its original size. Even in these days of steam drills the work of driving a tunnel big enough to carry two lines of an electric railway through three miles of solid rock was a stupendous job, to be accomplished within eighteen months.

The tunnel is lined throughout with concrete, made partially from the crushed rock excavated. At the south portal, where the water has final egress, a hugh steel cylindrical pipe runs a long way into the tunnel, otherwise the terrific force of the escaping water would drive the pipe from the tunnel mouth. Into this pipe are riveted the almost vertical lines of pipe (the penstocks) running down the steep face of the cliff 328 feet to the power house, and also another pipe (called a surge pipe) which is thrust directly up the side of the mountain, and acts as an escape pipe to take part of the first strain off the penstocks. A set of powerful valves, or gates, at the intersection of the penstocks with the main pipe will be controlled by electricity from the switchboard below in the power house.

The situation of the power house is superb. Through the narrow canon rushes the river, deep green in color, cruelly swift and strong, and rising abruptly from the water, four hundred feet and more on either side, are wooded cliffs, crowned by lofty pines, and at each end of the canon, open out other vistas of forest and stream and far distant mountains.

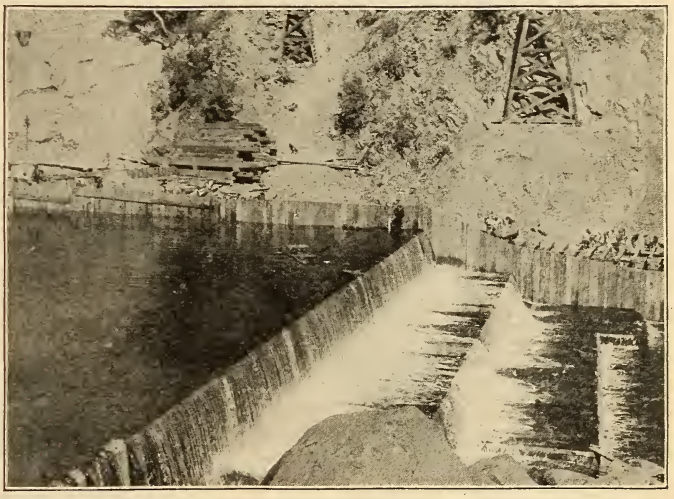
On the verge of the river, against this background of imposing grandeur, stands the power house. It looks like a modern castle, massive, but beautiful, in the style of the Italian renaissance. The graceful simplicity of its lines, the arched facade, the cool gray of the concrete, are thoroughly in harmony with the natural beauty of the gorge.

The foundations of the power house are 23 feet below the bed of the river and one of the most difficult and hazardous parts of the whole work was the building of the coffer dam outside of the proposed foundation, in order to lay dry the bed of the river. There were three anxious days in December, 1907, when the river, swollen to a record flood stage, threatened to sweep away the coffer dam. This meant that the previous six months' work of preparation would go for nothing, thousands of dollars' worth of

machinery would be destroyed, the building of the whole plant put back a year, not only entailing a loss of half a million dollars, but also having a disheartening effect upon the entire personnel of the company, from the engineers who had planned it all, and the stockholders whose money meant faith in those engineers, down to the workmen who blindly obeyed orders. The tension of that last stormy night on the dam, the white fury of the river, the long, shadowy lines of men, moving ant-like, steadily up and down the face of the cliff filling and refilling the bags of earth to strengthen the dam, is one of the memories not easily forgotten.

On the lowest floor of the power house the draught tubes discharge the dead water from the turbines out under the river, and rising from the level of the river upon the first floor of the structure are the four seventy-inch 18,000-horse-power high pressure turbines running at 400 revolutions per minute. Later, there will be eight such units in operation. These are direct connected through the next floor of the power house by massive vertical shafting, to four dynamos on the top floor, each of which delivers 10,000 kilowatts (13,500 horsepower) of electrical energy. By means of water cooled, oil insulated transformers, electricity is then stepped up in voltage from 11,000 to 100,000 volts, and carried by the transmission lines to the Oakland substation. This high voltage is selected because of the economy that it secures in sending the power a distance of one hundred and sixty-five miles to the coast.

Obstacles to be surmounted in beginning this work were enormous. The nearest railroad was thirty miles away over a narrow foot trail, across the mountains. Roads had to be built first of all, and supplies hauled in from Oroville, or Marysville, the nearest towns. Within the past year, however, the Western Pacific Railroad has come into the canon of the Big Bend, on the opposite side of the river from the Great Western Power Company. The supplies and machinery for the power plant are now taken from the cars at Las Plumas, the Western Pacific station, swung on a powerful aerial cable two thousand feet across the chasm, and landed at will, either at the portal of the tunnel, or down through an opening in the roof directly into the heart of the power house.



THE BIG BEND POWER DAM

THE FUSE FOOL.

There is a most varied assortment of fools on this planet, as any half observant person can easily discover in the course of an ordinary day's experience, says Electrocraft, but of all fools that infest the world, that particular fool who substitutes a nail or a hairpin or some such device in place of a blown fuse is the kind that neither God nor man has any use for. He is a malicious fool, and he has the cunning of the coyote besides. For some other varieties of the genus fool, one's disapproval is sometimes tempered by sympathy for their foolishness. The "unloaded" gun pointer, the boat rocker, the banana-skin thrower are more stupid than malignant, and stupidity is not always incurable. But the fuse "fixer" has not even the poor excuse of stupidity. He generally knows, or he should know, the probable consequences of his act, yet he cunningly sneaks in a device which is almost certain sooner or later to cause destruction of property, and possibly human life as well.

ELEMENTARY ELECTRICITY

BY PROF. EDWIN J. HOUSTON, PH. D. (PRINCETON.)

CHAPTER XV.—ELECTRIC SOURCES. FRICTION.

As already pointed out, all electric circuits consist of conducting paths by means of which the electricity produced by electric sources is passed through various electro-receptive devices so as to obtain some of the many effects electricity is capable of producing. These paths or circuits lead the electricity from the positive pole or terminal of the source through the receptive devices, and then, when it has produced the effects desired, lead it back to the source at its negative pole.

Having described the principal electric circuits and the various effects produced by the passage of electric discharges both through ordinary matter as well as through the residual gaseous atmospheres of high vacua, it remains first to describe some of the more important electric sources, and afterwards some of the electro-receptive devices that are most frequently employed in actual practice.

It might at first sight be supposed that it is very difficult to produce electricity. On the contrary, however, it is so easy to do this that it is extremely difficult to expend energy in producing such mechanical effects as friction, flexure, torsion, elongation, compression, etc., without at the same time producing electricity, and the same is true when energy is expended or caused to do work in producing heat, light or magnetism.

One of the simplest ways of producing electricity is by the friction of unlike surfaces or substances. When certain precautions are taken it is impossible to rub two different surfaces or substances together without producing well marked electric excitement. It seems strange, therefore, that it was not until some 600 B. C. that a Greek philosopher, Thales, discovered the strange power a piece of amber acquired, when rubbed against the clothing, of attracting light objects towards it. But it was still more strange that this important observation was permitted to lie unnoticed until some 2,200 years afterwards, when, in the year 1600, Dr. Gilbert, of Colchester, England, who lived during the reign of Queen Elizabeth, repeated Thales' experiment and found that similar properties were acquired by the friction of a great variety of other substances.

One of the simplest ways in which electricity may be produced by friction is to rub a dry glass rod with a dry silk handkerchief. When such a rubbed rod is brought near small pieces of paper, shreds of straw, or feathers, they will be drawn towards it as shown in Fig. 93. Occasionally, some of these pieces, after remaining

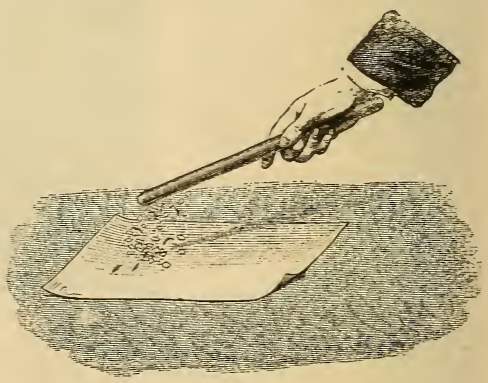


FIG. 93. ELECTRIC ATTRACTION OF LIGHT BODIES

in contact with the rod for a few moments, will be thrown off or repelled from its surface. If, however, a number of small rounded balls formed from the pith of dry elder wood are employed, instead of the irregularly shaped fragments that necessarily contain corners or points, after remaining momentarily in contact with the rod, the ball will be shot off from it and again attracted in an amusing manner.

The approach of a rubbed glass rod to a pith ball suspended by a silk thread from an insulated support, as shown in Fig. 94, results in the ball being drawn towards the rod. After remaining for a moment in contact, the ball will be shot off violently from the rod and can no longer be attracted until it is touched by something connected with the ground.

If a black rubber comb, or a sheet of vulcanite, the substance from which the comb is made, is rubbed with a piece of cat's skin or other fur, similar electric effects are produced.

Perhaps one of the simplest ways in which electricity can be produced by friction is by placing a small sheet of white writing paper, that has been thoroughly dried on the top of a stove sufficiently hot to

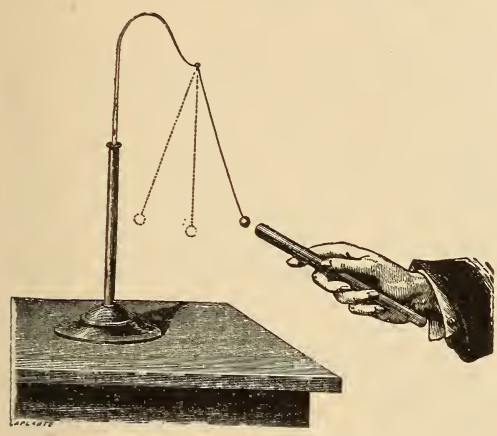


FIG. 94. ELECTRIC PENDULUM

dry it without burning, on a piece of smooth wooden board that has been similarly dried. If the paper is now briskly rubbed with a bit of India-rubber such as is employed for erasing lead-pencil marks, it not only acquires the property of drawing a suspended pith ball towards it, and

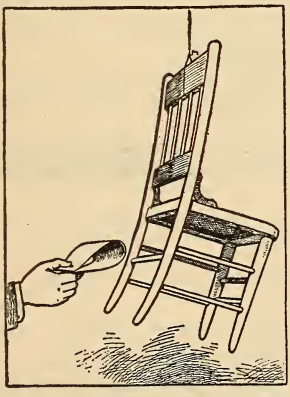


FIG. 95. ATTRACTION OF CHAIR BY ELECTRIFIED SHEET OF PAPER

repelling it, as does a rubbed glass rod, but also of attracting or being itself attracted by unelectrified bodies; for, if brought near the wall of a room it is immediately drawn towards he wall, to which, provided the air be fairly dry, it will cling for several hours. If brought near a suspended chair as represented in Fig. 95, it will attract the chair and cause it to move out of its vertical position.

The glass rod, the rubber comb, or the piece of paper that by rubbing has acquired the property of attracting bodies towards it, or of receiving electricity by friction, is said to be electrified or excited. The condition in which it existed before rubbing is said to be unelectrified or unexcited.

If the rubbed glass rod, piece of vulcanite, or a sheet of paper, is drawn to and fro near the face but without touching it, a feeling is experienced as if cobwebs were drawn over the skin. If a knuckle of the hand be approached to the excited body, in a dark room, a faint bluish spark will be

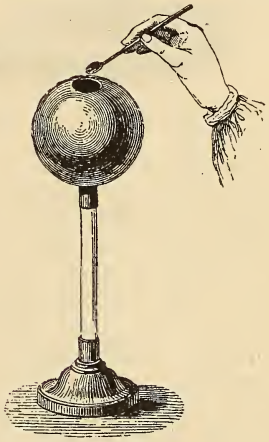


FIG. 96. ELECTRICITY RESIDES ON THE SURFACE

seen accompanied by a feeble explosion or snap, phenomena that in miniature are the same as the lightning and thunder that occur on a grander scale in the atmosphere during a thunderstorm.

If an electrified body is touched to a hollow copper sphere supported as shown in Fig. 96 on an insulated stand, the electricity spreads over its surface as a uniform and exceedingly thin layer. This can be shown by the approach of a small carrier or "proof-plane" consisting of a disk of copper foil supported on a slender glass rod. When this disk, held by the slender rod, is touched to any part of the surface, it takes off a small charge, the value of which can be determined by suitable apparatus. The electricity, however, resides only on the surface of the insulated ball or sphere. None whatever can be found on the inside; for, if the sphere is provided

as shown, with an opening, say about an inch in diameter, the proof-plane, touched to any part of the inside, takes off no charge whatever. The electricity imparted to the sphere has spread through its conducting mass until it reaches the surface, where it is retained by the non-conducting power of the air.

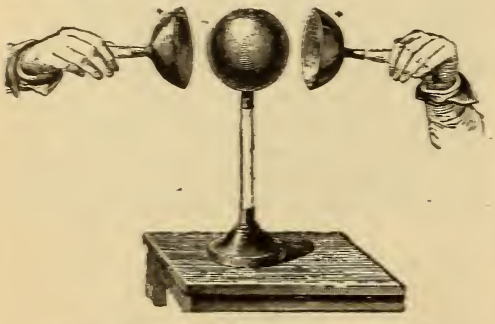


FIG. 97. DISCHARGING A SPHERE

If the diameter of the insulated globe is increased by the close approach of two closely fitting insulated hemispheres, represented in Fig. 97, the charge previously existing on the insulated sphere, leaves it and flows to the surface of the hemispheres. When these are withdrawn they will be found to possess all the electricity, none whatever remaining on the sphere.

In a similar manner if an electric charge is given to a strip of tin foil, wrapped closely in a tight coil around the surface of a metallic cylinder supported by two upright glass pillars, so as to turn on a horizontal axis, a pith ball suspended by a silk thread to a metallic upright connected with the cylinder is first attracted and then repelled from the vertical metallic supports. When, by the movement of the handle, the strip of tin foil has the area of its free surface increased by being unwound, the charge, spreading over the surface, covers it with a thinner film. In other words, the electric density, or the quantity of electricity per unit of charged area, is decreased, as is shown by the decreased repulsion of the ball, which now falls nearer to a vertical position. When, however, the strip of foil is again wound closely around the surface of the cylinder the density of charge again increases and the pith ball is thrown further from its vertical support.

The pith ball in the above apparatus forms what is known as an electrometer, or device for measuring the quantity of an electric charge. It does this roughly by the distance through which the pith ball is moved from its vertical position when at rest.

An electric charge imparted to an insulated sphere possesses a uniform density at all points of its surface. In the case of any other surface, however, the density is greater at some places than at others. In the case of a cylinder, it is greatest at the edges of the cylinder. In the case of an egg-shaped body it is greatest at the end or point of the egg. If there be any sharp corners or points on an electrified surface, the electric density is greatest at the points. Indeed, this increase in density may become so great at a point as to permit a discharge to take place.

The electrified body has received what is known as an electric charge. When touched by a knuckle of the hand, it parts with or discharges its electricity, the electricity flowing through the body of the person to the ground. There are, therefore, two conditions in which electricity may exist; i. e., as an electric charge, or when the electricity on the body is at rest, and an electric discharge or current, or when the electricity is in motion. The value of an electric charge is determined by the extent of the charged surface and the electric density, or the depth of the electric layer; the value of an electric current by the quantity of electricity that passes per minute.

That branch of electricity which treats of effects produced by electric charges, or

FIG. 98. ELECTRIFICATION OF METAL

by electricity at rest, is known as electrostatics.

Going back now to the experiment represented in Fig. 93, it can be understood why the irregularly shaped fragments of paper, straw or feathers were not thrown from the electrified glass rod to which they had been attracted as strongly as were the rounded pith balls; for, the surface of these irregularly shaped fragments acquired at the points such an electric density as to partially discharge into the air. The rounded balls not suffering this loss were more strongly repelled.

The discovery that certain substances possessed a conducting power for electricity

was made by an English physicist, Stephen Gray, in the early part of the Eighteenth Century. Before this time it had been observed that many substances such as the metals were apparently incapable of being electrified by friction. These bodies were called non-electrics in order to distinguish them from glass, sulphur, hard rubber, etc., called electrics, that were readily electrified when rubbed. Gray discovered that all bodies can be electrified by friction provided they are supported on non-conductors of electricity. For example, a rod of brass provided with a glass handle as shown in Fig. 98, can readily be electrified by friction, if held by the glass handle while being rubbed.

Among a variety of other experiments, Gray showed that an electrified glass rod could readily communicate its electricity to a brass globe supported as in Fig. 99, for, when one hand of the boy was touched to the insulated cord electricity was communicated to it from the far end, so that the body of the boy became electrified and attracted pith balls to his free hand when held over the plate as shown.

Substances differ greatly in their conducting power. As a rule the metals are good conductors of electricity. They differ, however, greatly among themselves, some, like gold and silver, being excellent conductors, while iron, lead and antimony are poor conductors. On the contrary, glass, wax and hard rubber are poor electric conductors or non-conductors.

The substances in the following table are arranged in the order of their electric conducting power, being good conductors, semi-conductors and non-conductors or insulators.

CONDUCTORS	SEMI-CONDUCTORS	NON-CONDUCTORS OR INSULATORS
Metals	Alcohol	Silk
Graphite	Powdered glass	Precious stones generally
Pure acids	Flowers of sulphur	Mica
Dilute acids	Dried wood	Glass
Solutions of salts	Paper	Amber
Ocean water	Straw	Agate
Spring water	Dry metallic oxides	Wax
Rain water	Phosphorus	Solid sulphur
Snow	Porcelain	Resins
Living plants and animals	Leather	Shellac
Linen	Parchment	Vulcanite
Cotton	Dry paper	Dry air or gases
	Hair	Extremely high vacua
	Feathers	

In order to study the effects produced through a hempen cord for a distance of 765 feet, provided the electricity was prevented from escaping from the cord to the ground by resting it on glass uprights as shown.

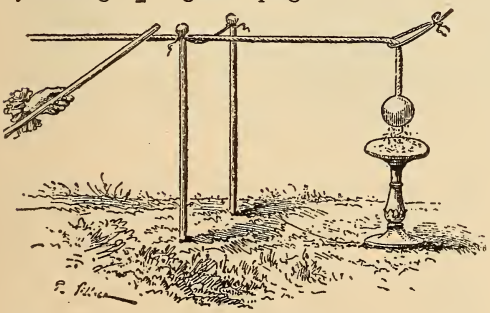


FIG. 99. GRAY'S EXPERIMENTS IN CONDUCTION OF ELECTRICITY

That the human body is a conductor of electricity was demonstrated by Gray by suspending a boy by silken cord from the ceiling of a room, as shown in Fig. 100; by rubbing different bodies together, two separate pith ball pendulums may be employed. If a glass rod, rubbed with a silk handkerchief, is touched to each of these pith balls it will be found that when brought near one another the balls will mutually

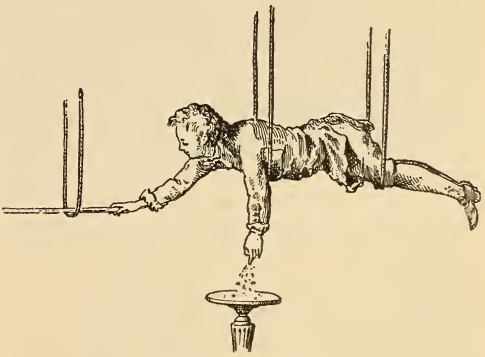


FIG. 100. ILLUSTRATING CONDUCTION OF THE HUMAN BODY

repel and move apart. If, however, one of the balls be touched by a glass rod electrified by rubbing with a silk handkerchief and the other by a rod of sealing-wax rubbed against a piece of flannel, then when the balls are brought near one another they will attract as shown in Fig. 101.

Now it can be shown that the almost countless bodies that can be electrified by friction act either like the glass rod rubbed by silk, or the sealing-wax rod rubbed by flannel. It is evident, therefore, that there are only two different kinds of electricity, one of which was formerly called

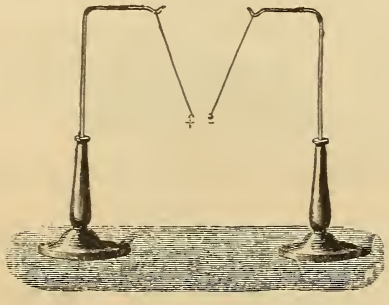


FIG. 101. OPPOSITE CHARGES ATTRACT EACH OTHER

the vitreous electricity or that produced by glass, and the other resinous electricity or that produced by resin. Since, however, it can be shown that the electricity produced on any body by friction depends not only on the character of the body itself, but also on the character of the body by which it is rubbed, the two different kinds of electricity are now known as positive electricity, or that produced in glass rubbed by silk, and negative electricity, or that produced by resin rubbed by flannel.

In the following table, a list of substances is given so, arranged that when any two of them are rubbed together the one standing nearer the top of the list becomes positively electrified, while the one standing near the end of the list becomes negatively electrified.

1. Cat's fur	8. The hand
2. Flannel	9. Wool
3. Ivory	10. Metals
4. Rock crystal	11. Sealing-wax
5. Glass	12. Sulphur
6. Cotton	13. India-rubber
7. Silk	14. Hard rubber

Thus, glass, when rubbed by silk, becomes positively electrified, but when rubbed by cat's fur, negatively electrified.

It can be shown that oppositely electrified bodies attract one another but similarly electrified bodies will repel one another. Or, in other words, like electricities repel, unlike electricities attract.

When two bodies are electrified by friction one becomes positively electrified, and the other negatively electrified. Moreover, the amounts of these opposite electricities are exactly sufficient to neutralize each other if allowed to come together.

It would appear, therefore, that the friction of one body against another produces electric excitement by breaking up something that exists in the bodies before friction.

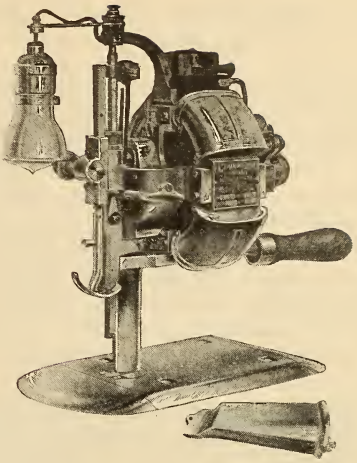
Various theories or hypotheses have been framed to explain the nature of electricity. The two theories most commonly adopted are known respectively as the single-fluid theory and the double-fluid theory. Neither of these is very satisfactory. It will be well, however, to explain them briefly since reference is constantly made to them in electrical works. We will discuss this subject more fully in a subsequent chapter on modern ideas concerning the nature of electricity.

According to the single-fluid hypothesis framed by Franklin it is assumed that there exists a single electric fluid, the particles of which are mutually self-repellant, but are attracted by all kinds of matter; that when these particles are combined with ordinary matter they lose their self-repellant tendency; that this electric fluid is present in all bodies, to an extent varying in each body; that all matter when in an unexcited state has exactly the quantity of electric fluid it is capable of holding without manifesting its presence; that a body becomes negatively excited when it parts with some of this fluid or when there is a deficit, and becomes positively excited when there is a surplus.

According to the double-fluid hypothesis proposed by Symmer or Du Fay there are two exceedingly tenuous, imponderable electric fluids, the particles of each of which are mutually repellant, but possess a strong attraction for one another; that is, particles of positive fluid repel particles of positive fluid, the particles of negative fluid repel particles of negative fluid, but particles of negative and positive fluids attract one another; that when they combine they hide or mask each other's presence; that a body is electrified by friction because of the breaking up of this union between the positive and the negative fluids, the positive fluid going to the positively excited body, the negative fluid to the negatively excited body.

The electrification of a glass rod by a silk handkerchief is thus explained according to the single-fluid hypothesis; the glass becomes positively excited because it takes some of the electric fluid from the silk which is thus left negatively excited. According to the double-fluid hypothesis the neutral fluid in both the glass and the silk becomes separated, all the positive fluid going to the glass, and the negative fluid to the silk.

(To be continued.)



ELECTRIC CLOTH CUTTER

ELECTRIC CLOTH CUTTER.

In establishments where "ready-made" clothing is manufactured there are of course hundreds of suits cut from the same pattern and it therefore becomes of advantage to use a cloth cutting machine which will cut many layers at once. Such a machine is shown in the illustrations. It is a portable device and can be moved around over the cutting table. It is operated by an electric motor and is provided with an incandescent lamp for illuminating the work at close range when desired. The motor actuates a reciprocating knife which cuts through several inches of cloth with incredible rapidity.

An overhead track from which the machine is suspended may be added to facilitate its operation.

ELECTRIC CLOTH CUTTERS IN OPERATION

GROWTH OF ELECTRIC PLANTS.

Illinois has the largest number of electric plants, 398, though outside of Chicago few of them are of considerable magnitude. New York has 358 and Pennsylvania 346, the last state gaining 14 in the six months, which is rather remarkable for so settled a commonwealth. Ohio has 289, Michigan 253, and Texas the large number of 288, surpassing Indiana with 218 and Iowa with 207. Oklahoma has already 76 and New Mexico 15.

RAPID PRODUCTION OF STEREOTYPE MATRICES.

In the modern newspaper office, time is of great importance, particularly in the production of the frequent editions of the afternoon papers. These papers find it necessary to get out editions at close intervals, and unexpected events are liable to entail sudden and radical changes in the makeup. Each change in the makeup of a page requires a stereotype matrix from which the plates for the presess are cast. The sporting edition, in particular, is a source of daily trial and worry.

Owing to this daily race with time the newspaper offices are the most progressive in the world. The pressroom and the composing room have been speeded up by the

ELECTRIC MATRIX DRIER

use of the most modern machinery. The casting of the stereotype plates is done by an automatic machine that finishes them ready for the press. The making of the matrix for these plates has remained the longest step in the process, owing to the time required to dry out the matrix.

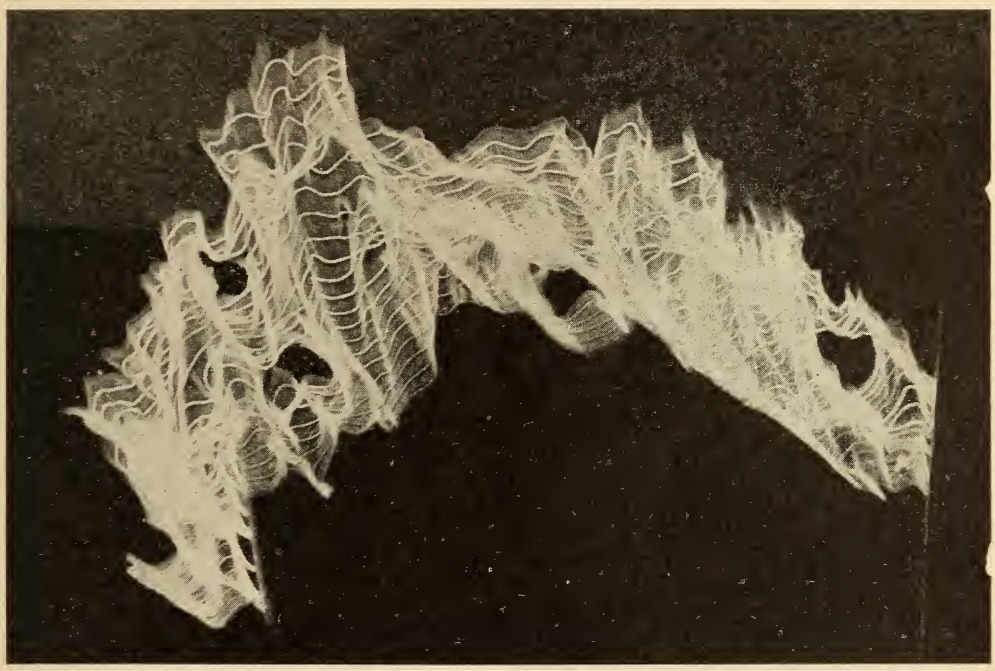
Steam and gas heated matrix driers have been, heretofore, the only matrix driers which successfully withstood the service in newspaper offices. A number of attempts have been made to increase the speed at which matrices could be dried out, including attempts to apply electric heat to the process. Owing to the localization of the heating element so as to transmit the heat directly to the type and matrix, it was evident that this method would be more rapid than any other, which was finally demonstrated.

In order to understand the difficulties to be overcome, it is necessary to consider that the matrix should be completely dried in from three to five minutes. This requires an excessively high working temperature. When the attempt was made to work with the high temperatures on a steam or gas heated matrix drier, the type or slugs were damaged. The beds of these presses were made as thin as practicable in order to transmit the heat rapidly. This made it necessary to raise them to an exceedingly high temperature so that they would be able to heat the type rapidly. In practice it was found that in order to cut down the time of drying the matrix, these beds had to be heated to a temperature that caused serious damage to the type. In 1903 the first installation of electrically heated matrix driers was placed in the Government Printing Office, Washington. Since then several very successful installations have been made, among them are the Peoria Journal, Peoria, Ill.; the Louisville Courier-Journal and the Brooklyn Daily Eagle. The time for thoroughly drying a matrix has been reduced to less than three minutes in an installation of matrix driers at the plant of the Philadelphia Bulletin.

These driers are equipped with safeguards to prevent their overheating, and in spite of their high working temperature cause no damage to the linotype slugs. One of them is shown in the center of the illustration. The ability to maintain a high working temperature in the matrix drier arises from the heavy cast iron bed plate in which the heating element is hermetically sealed. This bed acts as a thermal storage reservoir and its upper surface is maintained at a very high heat by the heating element embedded just below this surface. The comparatively cool form rapidly absorbs this surface heat and is quickly raised to a temperature sufficient to thoroughly dry out the matrix in a trifle less than three minutes, or in from one-third to one-half the time required by steam or gas heated matrix driers.

THE PROBLEMS OF HIGH VOLTAGE TRANSMISSION.

With the advent of high voltage power transmission lines, electrical engineers have become more familiar with the operation and peculiar phenomena incident to the high tension discharges, and the construction of transformers for this work has been ahead of the demands until it is now proposed to transmit power to Cape Town from Central Africa at 500,000 volts. This would have seemed impossible a few years ago, but now practical transformers for this pressure are built with modern materials and tools.



DISCHARGE AT 1,000,000 VOLTS PRESSURE

The arc shown in the picture is a reproduction of an actual photograph taken from discharge of a 1,000,000 volt, 150 horsepower transformer, designed and built by C. H. Thordarson of Chicago, who is well known as one of the electrical "wizards" of the day and whose laboratory experimental work has done much to add to the present knowledge of high-voltage and high frequency phenomena.

Indications are favorable for much future progress in the field of high tension power transmission. The problem is now largely a mechanical one; that is, to construct insulators for the line which will stand the pressure that modern transformers can be made to develop. The new suspended type of insulator, which is really one insulator above another like beads on a string, seems to offer a solution, and even now is carrying voltages that a year ago would have been thought impracticable.

THE ELECTRIC IRON IN THE TANNERY.

It is not generally known that the finish upon fine leather is largely produced with electric irons. A hide or skin, after it comes from a tanning wheel or vat, is far indeed from the handsome appearance it presents after being made up into shoes, pocketbooks, traveling bags, etc. It looks more like an old dishcloth and smells like the dead past and a boiled dinner.

A hide is finished in about the same manner as a fine shirt is laundered. First the leather is hung out to dry. Then the pores of the skin are filled up with dressing which gives substance to the leather in the same manner as starch is applied to the family washing. After this process is completed the leather is smoothed and ironed with the electric irons until it is smooth and glossy.

STARTING A TROLLEY CAR

BY ALBERT WALTON.

The engineer at the throttle, tense, watchful, alert, has always served as the example when defining the word "responsibility." Upon his keenness and his faithfulness depend the lives of the scores of men, women and children rushing headlong through space, trusting solely to him for their safety. No less nerve-racking are the duties of the thousands of men who stand for 10 and 12 hours at a stretch in our cities on the front platforms of our electric street-cars. Not only does the motorman have the safety of his passengers constantly on his mind but also he must be eyes, ears and brains for the reckless teamsters, the absent-minded men, heedless children and nervous women. This thought comes to all of us at times and we praise the true eye and steady nerve of the man in blue who brings us safely through the maze of traffic, but who of us realizes that the human element is only half of the story and that our ride and its safety depend fully as much on the successful operation of the mechanical devices operated by this man whose deft hands bring them into action.

It is not enough that the motorman never for an instant takes his hand from brake or controller handle. Brake and controller must do their part, likewise, with never failing precision. A bolt loose here, a contact finger failing there, may mean wholesale death and destruction.

What, then, is this controller upon which so much depends? What is inside the mysterious black box with the brass crank on top? How and what does the controller control? We have seen the motorman move the crank handle a notch to start the car and then in an instant another notch—a little later another and another, and if we have been observant we have noticed he let the handle rest in the fifth notch unless he wanted to run the car at top speed, as he does sometimes after he leaves the crowded city. If he does want his car to make its best time he quickly passes from the fifth to the sixth notch and then slowly again from notch to notch up to the last point, which is usually the ninth notch. But a good motorman runs his car on the fifth or the last notch, according to whether he wants half speed or full speed, and never lets the handle dwell on the other notches more than a few seconds. If there is some reason why he may not go full speed, he will go half speed. If he may not run at half speed he will give the car a start by using the second or third notch and then quickly shut off the power entirely, letting the car "coast" along by itself slowly until another impulse is needed. But you never see a good motorman run for any length of time with the controller on these intermediate notches. Why?

You will understand this better when you know what the controller is designed to do. Its function is to control the amount of electricity supplied to the two motors under the car so as to control the speed of the car itself. This it does by regulating the amount of electrical "pressure" applied to the motors. The greater the pressure applied to the motor the higher the speed.

The pressure in the trolley wire is always about the same—500 volts, a volt being a measure of electrical pressure just as a pound is a measure of water pressure. Now, since the trolley has a definite constant pressure, and the pressure on the motor must be varied to change the speed, a way must be found to choke down the trolley wire pressure so as to bring only part of it to the motors, and this is what the controller is for. In the controller is a row of "fingers" arranged on one side from top to bottom of the box. Attached to the motorman's crank-handle is a cylinder or "drum" with projections on it so arranged that when the motorman turns the handle, these projections come in contact with the fingers one after another in a certain definite order. (See Fig. 1). But until he turns it there is a space between the fingers and the projections on the drum. A wire runs from the trolley pole to two of the fingers and carries to them the trolley pressure of 500 volts. When the motorman turns his handle to the first notch, he moves the drum so that two projections on it touch these two fingers and, at the same time, another projection touches another finger of the row further down. In other words it bridges the space between this top pair of fingers and the other finger, and allows the electricity to pass across the gap, for

the drum is made of metal and the current can flow through it very readily. From this point a wire carries the current to the motors, first, however, passing through a series of "resistances" (see Fig. 2), which choke down, or cut off part of the pressure. The current then flows under diminished pressure from the last resistance grid to one motor and from that to the other motor. So each motor gets only half the pressure remaining after the resistance grids have cut it down and the car, therefore, starts gently and slowly.

The next notch on the controller bridges between the upper pair of fingers and still

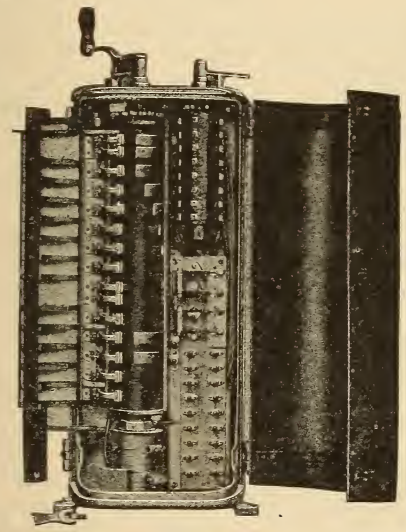


FIG. 1. INTERIOR OF THE MYSTERIOUS CONTROLLER BOX

another one lower down. This second move cuts out part of the resistances and allows the motors to have a little more pressure and develop a little more speed. The third notch cuts out a little more, the fourth still more, and the fifth cuts out the last of it. There is now a bridge to the fifth of the lower fingers and the current from the trolley passes directly with undiminished pressure to the two motors, each of which has half of the pressure, or 250 volts, put upon it, since they are "in series," the current passing from one to the other. On this notch they will therefore run about half speed and no current is being wasted in the resistance grids. If it is desired to run faster the full trolley pressure can be put directly across each motor by itself, when it will develop full power and run full speed. But this is too great a change to make directly. The car would jump violently if full pressure were to be thrown on in one move. It is therefore necessary to use the resistances again to make the steps more gradual. The sixth notch, then, sends the current through all the resistances, again cutting down the pressure so that what remains can be put directly upon each motor by itself instead of the two in series. This is done by the controller sending the current over a divided path over two parallel wires to each motor which thereby gets the full pressure less what has been taken off by the resistances. These are then cut out step by step as before till on the last notch the full 500 volts of the trolley are impressed on each motor and the car comes to full speed, no current at all passing through the resistances. This is called running "in parallel" since the current has two parallel paths, flowing, as it does, through the two motors at once.

The reason, therefore, the motorman does not run on any but the two positions where the resistances have been switched out is because there is a waste of power just in proportion to the amount the pressure is cut down. The power wasted is thrown away as heat. The grids become very hot even when the motorman is careful to keep them in use as little as possible. If he should keep on running on the notches where the resistance is used the grids would get red hot and be likely to melt or burn up. You can see these resistance grids, by the

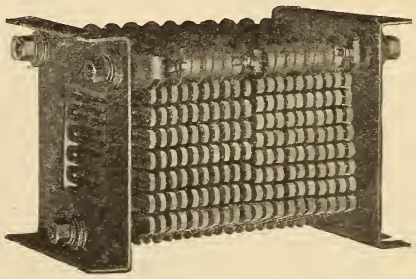


FIG. 2. RESISTANCE GRIDS

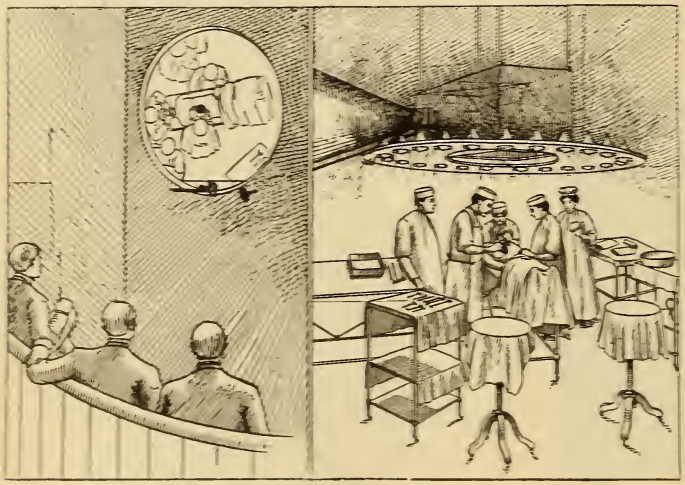
way, under almost any car. They are hung from under the car floor and are usually in plain sight right at the edge of the car about half way between the platforms.

Like most other successful inventions, this is very simple and easy so understand and does what is expected of it time after time without hitch or failure, and yet it

never occurs to us to mingle with our praises for the motorman's good work a few words, no less deserved, in praise of the geniuses who have worked out and perfected the details of the devices which make our rapid transit possible.

ELECTRIC PROJECTOSCOPE FOR CLINICS.

The present method of witnessing clinical operations is for the students to gather on the high tiers of benches surrounding the operating table. This is not only an unfavorable position for observation but also increases the danger of infection of the patients being operated upon, for the many



OBSERVING AN OPERATION BY THE PROJECTOSCOPE

people moving into the room and to the high benches stir up a great deal of dust which gradually settles over the seat of the operation.

A method of observing operations by means of powerful electric lights and a projectoscope has been designed by Dr. Charles H. Duncan, of New York City. The sketch shows very plainly how it is used. Over the table are placed a great many electric lamps which have reflectors to throw the rays downward. Through the circular shield is an opening into a sort of camera-like box. In this box are suitably adjusted mirrors to throw the reflected image of the patient, surgeon and attendants upon a screen as shown. This screen may be placed in the wall of an adjoining room where the students are seated. The operating room is therefore entirely cut off and may be made entirely free from floating germs.

PLATING WITH PLATINUM ON CHEAPER METALS.

There is little or no difficulty in electroplating the noble metals with platinum, but when it comes to producing an eletroplastic coating on the commoner metals, there has been trouble, especially where the body metal is required to resist high temperatures. A new process, however, has been patented in Germany by Baum, of Hanau-on-the-Main, which permits the plating of an object with platinum, thereby forming a substitute for pure platinum which resists high temperatures.

In this process there are employed the metals of the iron group, the members of which, as for instance iron, nickel and cobalt, have a high melting point, but readily form alloys which have a similar coefficient of expansion to that of platinum.

In order to give the metals of the iron group a durable coat of platinum by the electrogalvanic process, the usual way has been to plate them first with copper and then with platinum; or else to give them a coating of an alloy of platinum and some one of the metals of the lower order, as distinguished from those of the "noble" group. This latter process is suited for all cases where the demands upon the platinum coating are not very severe, but if, for instance, it is required to resist a temperature of from 900° to 1,000° C., there is difficulty from the flaking off of the coating. Platinum alloys well with copper (according to Muspratt at 350° C.), but both it and the copper flake off at the higher temperature mentioned above.

According to the new invention there can be attained a good electrolytic coating of platinum on the non-noble metals or alloys thereof, as for instance on nickel, as follows:

An object of nickel wire or sheet is prepared by the usual methods for electroplating, and then treated in an electrolytic bath consisting of a solution of 25 per cent of platinum and 75 of nickel. By employ-

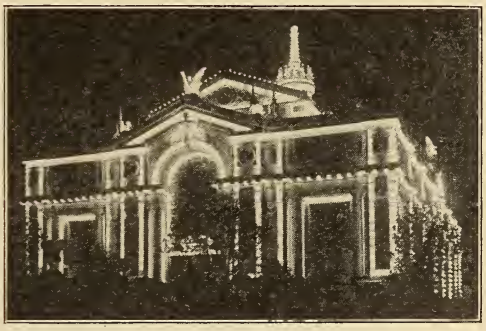
ing a current of the proper tension and quantity (say 0.6 to 0.8 amperes for each square centimeter, with a tension of four to six volts), the result is a coating containing a small proportion of platinum, and a great deal of nickel. This layer is burnished and dried in the usual manner, and the articles then heated to 900° to 1,000° C. in hydrogen. The result is that the coating is welded on the inner metal, the hydrogen seeming to act by catalysis, or rather by penetrating into the pores of the metals and binding them together. The articles thus treated are then placed in a second bath, containing a mixture of equal parts of platinum and nickel and after the deposit here effected is again glowed in hydrogen. After this it is plated for a third time in a bath of 75 per cent of platinum and 25 of nickel, and then for the third time glowed in hydrogen. The article then consists of a core of pure nickel surrounded by layers which merge into each other and which are richer and richer in platinum as they recede from the core.

After this, the objects are plated in a bath of pure platinum and for the last time glowed in hydrogen, this time at a temperature of 1,000° to 1,100° C.

NIGHT SCENES AT THE SEATTLE EXPOSITION

At night the Alaska-Yukon-Pacific Exposition, now being held at Seattle, Wash., presents a scene such as can be produced only by a lavish use of electric lights. What would an exposition be without electricity?

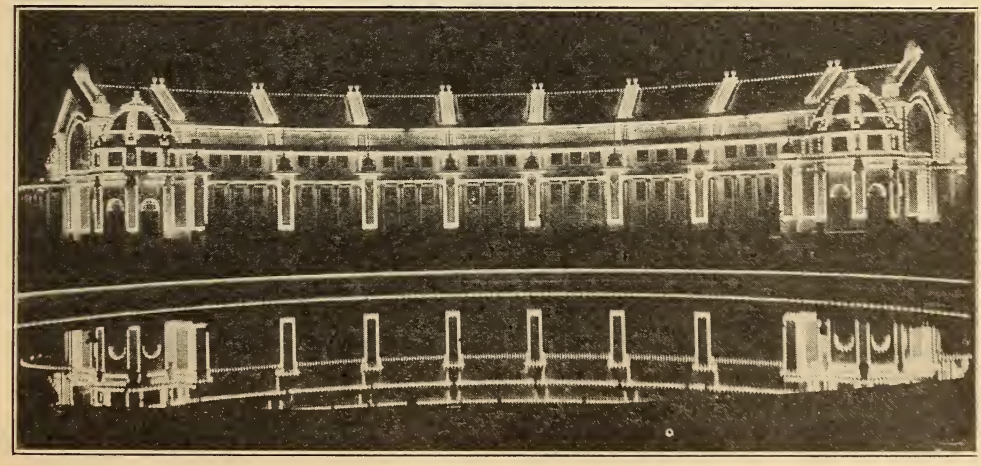
The Agricultural Building stands on the edge of Geyser Basin, and its myriad lamps are reflected with faithful minuteness in the placid waters of the pool. The Oriental Building, crowning a slight eminence on the shore of the basin, sparkles with the brilliancy of some priceless eastern gem.



ORIENTAL BUILDING AT NIGHT

The electical effects for the cascades and Geyser Basin are most beautiful, 8,000 gallons of water per minute being pumped by the electric equipment and brilliantly illuminated, in fountain and cascade efects.

Cascade Court is the central feature of the electrical effects of the exposition scheme. There is a series of dams provided for a distance



AGRICULTURAL BUILDING REFLECTED IN GEYSER BASIN

of 500 feet or more, down which thousands of gallons of water run in a raging torrent over thousands of colored electric lamps placed under the water at the lips of the dam. At night the effect of these lamps is startling, for they are placed behind glass of the prime colors with shading from the darker tones on the edges to lighter ones in the center.

GROOMING HORSES BY ELECTRICITY

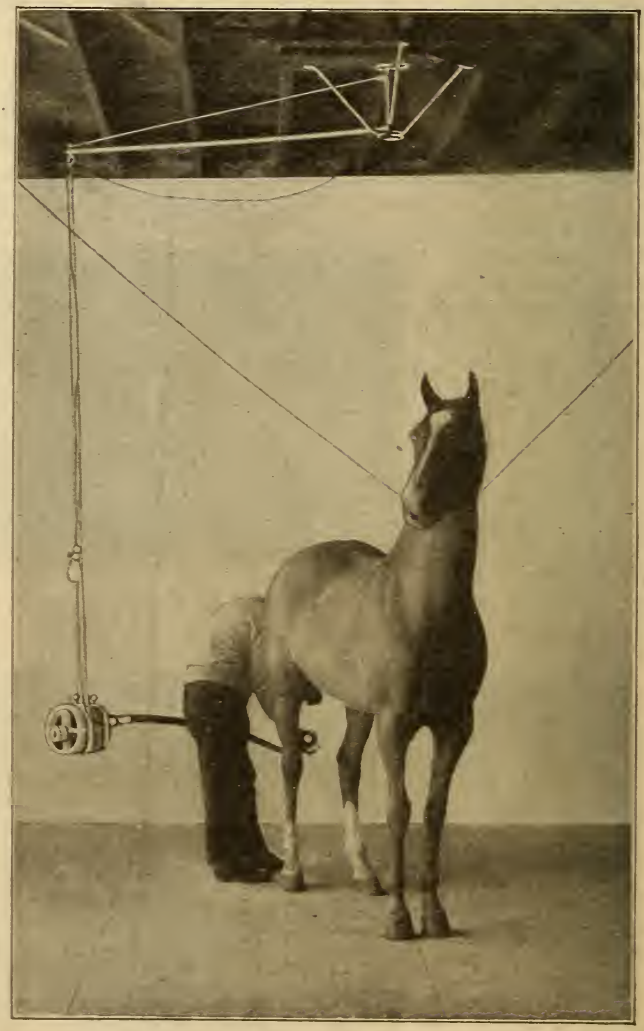
Leading horse authorities of the world and the most enlightened and progressive farmers and horse owners of every state and country, agree that horses should be clipped regularly and especially in the spring of the year. If a horse's coat is trimmed it is a simple and easy matter to keep it clean. It dries out rapidly, it does not become the lodging place of dirt, and the horse looks better and feels better. Horse grooming and clipping by machinery has long passed the experimental stage and these operations are regularly performed in this manner in most large stables. To simplify the operation electricity is now made to do all the work by a very simple arrangement which is shown in the accompanying pictures.

The horse clipping and grooming machine consists of a swinging bracket fastened to the ceiling from which is suspended a small motor which is provided with a flexible shaft extension on which may be used either a clipper or a grooming brush. The motor may be operated at various speeds, from 100 or 5,000 revolutions a minute. It operates on either alternating or direct current.

The clipping attachment is exactly like the ordinary clipper except that the reciprocating motion is performed by the flexible shaft from the motor instead of by the usual handles, greatly decreasing the labor and increasing the speed of operation. When using the brush attachment for grooming, the horse may be cleaned wet or dry in an incredibly short time, and the process is a most pleasing one, judging from the expression on the face of the one in the pictures.

Another feature of this electric brush is a pneumatic attachment which is a simple device constructed to utilize the current of air arising from the rapid rotation of the brush to protect the operator from the dust and dirt and deposit it upon the floor.

In operating the machine first place the horse under the swinging arm so that when the arm is swung around from one side to the other the motor will pass behind the

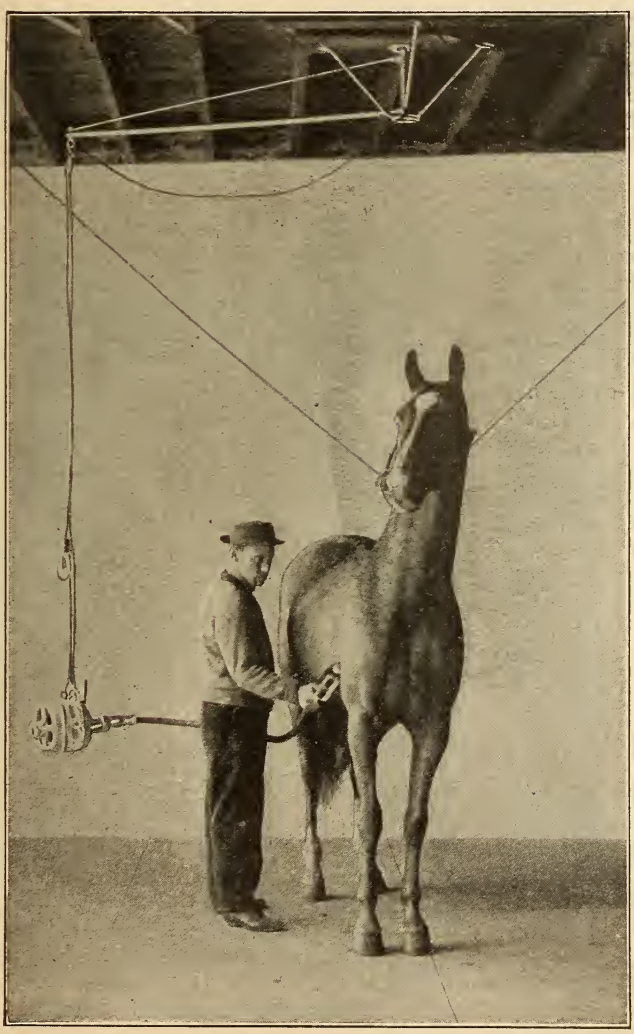


THE HORSE ENJOYS THE ELECTRIC GROOMING

horse, the best possible position being so that the support for the arm which is attached to the ceiling will be directly over the horse's withers or shoulder.

THE STORY OF TUNGSTEN.

On the work bench in the laboratory of the great electric works, before the powerful electric furnace, sat a small evaporating dish



ALL DUST AND DIRT BLOWN AWAY FROM THE OPERATOR

containing a handful of bright, steel gray powder of a peculiar metallic lustre.

"What is that?" I asked with true journalistic curiosity.

"That," answered the scientist, shaking the dish and disturbing the bright metal particles, "why, that is Tungsten, son of Phoebus, who gives us sunshine by night."

I had to confess that I did not understand his metallurgical metaphor.

"That little handful of powder there," he explained, "will make more than a thousand filaments for the new incandescent electric lamps. The filaments made from this rare metal, tungsten, will not only give a pure white light closely allied to actual sunlight but will give the same quantity of light as the old carbon filament lamp for one-third the current. Consider the millions of electric lights burned daily in the world and you can begin to grasp the importance of this wonderful metal which has leaped into such prominence and value in the last few months."

Ever since the discovery of the incandescent electric lamp by Thomas A. Edison twenty-five years ago thousands of inventors and scientists have been trying to improve upon the lamp. The original incandescent lamp filaments were made of carbonized strips of bamboo, which later were discarded in favor of the carbon filaments manufactured from cotton cellulose.

These lamps were the limit of extravagance as 98 per cent of the electrical energy was wasted in useless heat, while only two per cent turned into light. The scientists tried and are still trying hard to imitate nature and produce an electric lamp which will reverse these conditions and utilize nearly all the energy for light in the same way as the natural electric light is produced by glow-worms and fire-flies.

Tungsten, or wolfram, is a metal discovered in 1781 and named from the Swedish "tung" (heavy) and "sten" (stone). It is not found native but occurs as tungstate of iron and manganese in the mineral "wolframite," and as calcium tungstate. The fusing point of tungsten is

higher than any other known metal, which enables it to operate at the very high efficiency obtained in the tungsten lamp. One of the laws of incandescent light is that the higher the temperature the better the light and the greater the economy of current consumed.

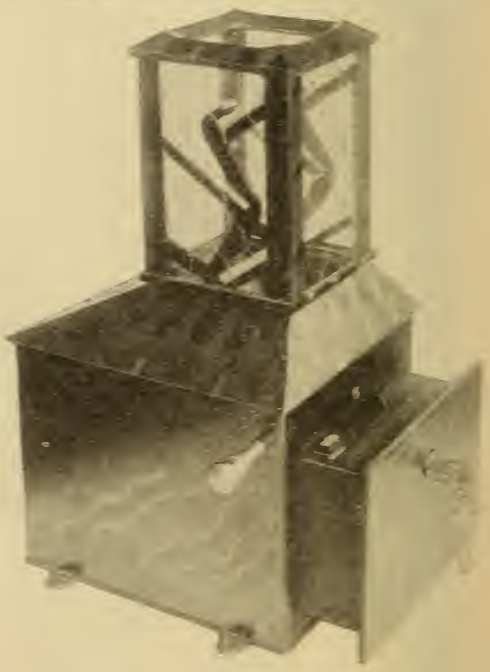
Up to two years ago tungsten was known only in laboratories and then only in a very impure state, and on account of its rarity the price was very high. But latter day prospecting has resulted in the finding of vast bodies of the ore and the price has correspondingly dropped to about $7 a pound. It would be even lower than this but for the difficulties in refining the metal. Only with the electric furnace is it possible to produce tungsten in its pure form. Pure tungsten is hard enough to scratch glass; it is almost impossible to melt it: it is malleable to some extent but not ductile. Because it cannot be drawn into wire the wire-like filaments in the electric lamps are made by the "paste" process which consists of mixing the powdered metal with binding or stiffening agents such as gums, dextrine, etc., until the mass has the consistency of putty. It is then squirted through a very fine orifice in a diamond with a pressure of several tons to the square inch. The result is a somewhat moist thread which has enough coherence to be formed into filaments which do not break while being dried. The filaments are first heated, then subjected to an electric current which causes them to sinter. The process of sintering is carried out in gases which chemically attack all the constituents of the binding agent, without the metal being affected, so that eventually a filament of pure tungsten remains.

The light from the new tungsten incandescent lamps is very nearly pure white. It is the first artificial illuminant by which all colors can be distinguished. Color is an ocular conception. Without light there is no color. A red substance is red only because it has the quality of absorbing all other colors of the spectrum and reflecting the red rays. Artificial lights in which the yellow, violet, or red rays predominate cannot be used to match colors. Under the clear white light of the tungsten lamps violet is not blue, pink is not red; and blue is not black as when looked at under other artificial light. The most delicate tints show clear and true.

The ordinary, now old-fashioned, incandescent lamp consumes 3.8 watts of electricity per candle power. The new tungsten lamp consumes only 1.2 watts or less than a third. This means that if a person is paying $3.45 for 23,000 watt hours (twenty-three kilowatt hours at 15 cents) of electricity consumed by the old lamps, for the same cost he could enjoy three times the light, and the quality would be better.

RECORDING STREET CAR FARES.

With the advent of the new prepayment or pay-as-you-enter electric cars in which the conductor stands on the platform, it became possible to utilize a form of cash register to actually receive the coins, giving an absolute check on the amount received.



CASH REGISTER FOR STREET CARS

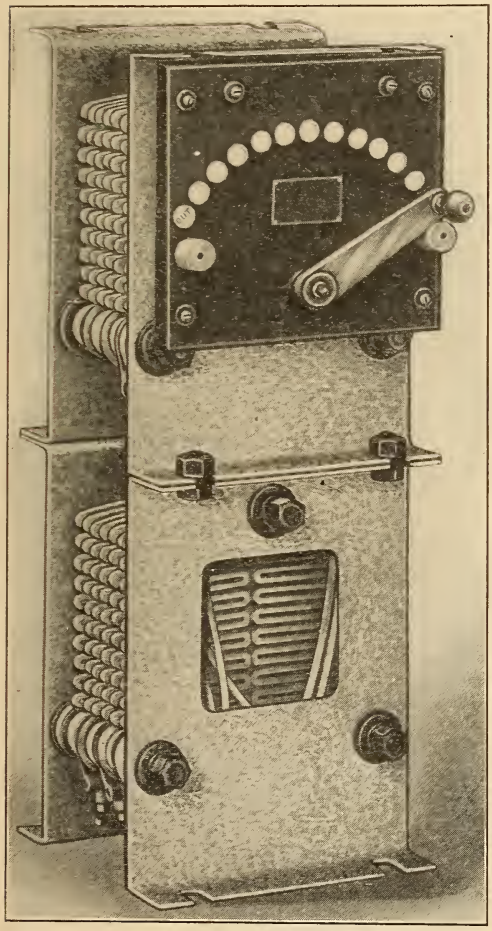
The passenger on entering the car drops his nickel into the wired glass receptacle at the top where it falls onto a shutter-like arrangement. After inspection by the conductor pressure on a thumb button drops the coin into the cash box, at the same time operating the register. A novel feature about this register is that it will not operate except by the presence of a coin in the machine. Without the coin the button may be operated any number of times without affecting the register.

The cash box locks automatically upon being removed from the machine, thus

making it impossible for anyone other than an authorized agent of the company to gain access to the cash.

HOW TO CHARGE BATTERIES.

The question of how to charge a storage battery is often perplexing to one having occasion to use one and who is not very familiar with the principle of the operation—for instance, the electric automobile owner. He is told at the beginning



BATTERY CHARGING RHEOSTAT

that, with the ordinary 110 volt direct current available, some form of resistance must be employed in the circuit, since the voltage at the beginning of the charge is less than is required when the batteries are nearly or fully charged, and it is therefore necessary to reduce the voltage, usually by what is known as an adjustable rheostat.

What is a rheostat, he asks; and how is it used? A rheostat is simply a number of coils of wire or small grid-like metal strips through which the current must pass in going from the source of supply to the battery. These resistances, as they are called, are mounted as shown in the cut, and are so arranged that by turning the handle seen at the top, over the little buttons or contacts, the resistances are one by one cut out of the circuit. As they are cut out less and less obstruction is presented to the flow of current into the battery.

To select a charging rheostat for a given service, the circuit voltage, the minimum allowable battery voltage and the charging current in amperes must be known. The required rheostat resistance in ohms can then be computed as follows:

$$\text{Resistance of rheostat} = \frac{\text{Circuit Volts} - \text{Battery Volts}}{\text{No. Amperes Charging Current}}$$

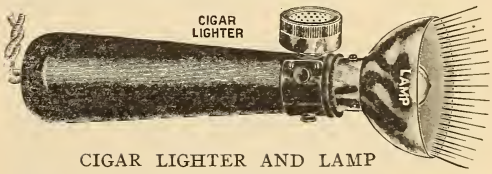
The battery voltage is the product of the number of cells in series and the volts per cell. For example, to charge a battery which has 36 cells connected in series, at a maximum rate of $7\frac{1}{2}$ amperes from a 110 volt circuit, the minimum voltage or the initial charging voltage being two volts per cell, the resistance in the rheostat would have to be as great as

$$\frac{110-(36\times 2)}{7.5} = 5.07 \text{ ohms approximately,}$$

and the standard rheostat with $5\frac{1}{2}$ ohms resistance would be required.

COMBINED CIGAR LIGHTER AND LAMP.

Automobile users will appreciate the Presto combined cigar lighter and lamp.



CIGAR LIGHTER AND LAMP

To light a cigar or cigarette, no matter how high the wind or great the speed, simply press the larger button and the little heating element on the side begins to glow. To light the lamp press the smaller button. This lamp is very convenient to use in looking for trouble or exploring for lost articles in the night.

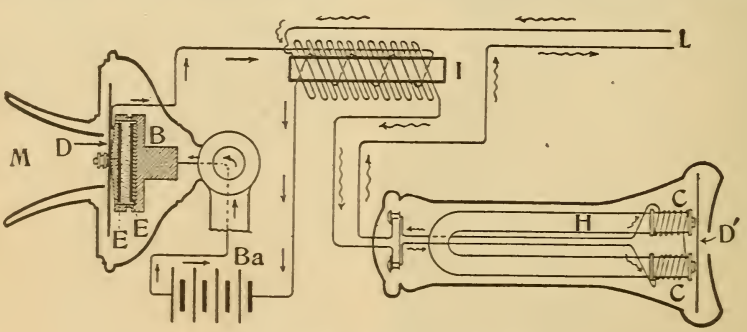
The device may be operated from the ignition batteries on the machine, and about 10 feet of cord will allow it to be used under, around or in any part of the machine.

HOW THE TELEPHONE OPERATES

BY PROF. B. A. PERKINS, A. B. (STANFORD).

Perhaps all of us are aware, in a general way, that sound is a sensation due to some sort of a disturbance created in the air. These movements in the air which excite our sense of hearing must be quite clearly understood if we would understand the operation of any sound producing apparatus.

In most cases we can quite readily perceive that a sound producing body is in a state of vibration. These vibrations of a sounding piano string can be seen and felt. But a vibrating body in order to cause the sensation of sound, must transmit its motion to the ear through the medium of the air. When a bell rings, the surrounding air is alternately compressed and rarefied, with the result that pulsations of the air or sound waves are sent out in all directions. As an example, middle C on a piano vibrates



SIMPLE DIAGRAM OF A TELEPHONE SET

256 times per second. This vibrating wire sends out 256 pulses of air per second, all of which impinge on the ear. The membrane of the ear is thereby made to vibrate 256 times per second. These vibrations are transmitted to the auditory nerves and the brain interprets them as sound sensation of definite pitch, loudness and quality.

There is a disk of metal or other elastic material in a telephone transmitter that responds to air vibrations, moving in unison with the air waves that impinge on it. In this respect, it is essentially like the membrane of the ear.

It must not be thought that these vibrations are passed on over the telephone wires. But the telephone, by means of the electric current, does produce secondary sound waves in the receiver that are in all essential respects like the primary sound waves of the transmitter. As these secondary sound waves from the receiver strike the membrane of the ear of the listener they are heard just as the primary sound waves would be heard.

The transmitter is, of course, that part of the telephone we talk into and the receiver is that part we hold to the ear. Perhaps it would be well to describe these parts in a little more detail by studying the diagram.

The transmitters now in use are called "variable resistance" transmitters. Their essential parts are: The elastic diaphragm (D) upon which the sound waves impinge and behind which lie loose carbon contacts, often in the form of small grains. The receiver consists of a strong permanent magnet (H), a small coil of insulated wire (C) surrounding one end of the magnet, and a diaphragm (D′) (a thin sheet of soft iron) placed very near but not in contact with the magnet and the coil. The essential parts of the transmitter and the receiver are protected and supported by a case.

Through the transmitter, over the telephone wire, through the receiver, and back over a return wire to the transmitter again, there flows a very weak current furnished usually by a few dry cells.

Let us now see what role this electric current plays. We have already noted that the telephone wire does not transmit sound waves. It does transmit pulsating (varying) currents which correspond in frequency to that of the sound waves. It is the part of

the transmitter to produce this variation in the current strength.

Those who have had any practical experience with electricity know that the effect of a loose contact between any two parts of a circuit is to increase the resistance and thereby weaken the current. But this effect is very much more than usually noticeable if the parts are carbon, as they are in the transmitter. Sound waves on the diaphragm of the transmitter cause a varying pressure on the carbon grains back of the transmitter and thereby a variation in the resistance to the current that is passing through the carbon grains. The resulting variations in resistance cause instant variations of current.

These fluctuating currents coming over the line pass through the insulated wire coil in the receiver and thus vary the magnetic field strength. This, in turn, varies the normal pull of the magnet upon the thin disk or diaphragm (D′) and as a result the diaphragm is caused to vibrate in accordance with the undulatory currents sent over the line. The like vibrations of the receiver diaphragm produce as an effect sound waves in the air like the casual air sound waves at the speaking end. This persistence of infinitesimal waves in all their sinuosities through repeated transfer and transformation may be regarded as one of the most wonderful and striking phenomena in science.

For operating the call bells on telephones, a small generator, called a "magneto," may be employed. This consists of an armature which by means of a projecting handle, can be revolved rapidly between the poles of a permanent magnet. The current thus produced is led to the distant telephone where there are usually two bells placed near together. The alternating current causes the bell clapper to strike them alternately as long as the handle of the magnet is being turned.

In every telephone we have a "signal" circuit and a "talking" circuit. It is seen that the current for the signal is an alternating current which may be generated by a small dynamo or magneto which we turn by hand. The direct but fluctuating current for the talking circuit is supplied in most cases by dry cells. We may operate either of these circuits at will, but not both at the same time.

When the receiver is on the hook, the magneto and bells are in circuit, hence we "ring up" before taking the receiver from the hook. When the receiver is taken down, the hook flies up, throwing the magneto and bell out of circuit. We are then able to talk to "central." When the subscriber rings up central, the current sent over the line from his magneto attracts the armature of an electro-magnet in the central switchboard and thereby releases a drop behind which is a plate carrying the subscriber's number. When the drop is down, it remains down until central puts it back. Once the subscriber's current has released this drop, no amount of turning his magneto handle will avail him any further. He may sometimes save his temper if he remembers this. When central notices this subscriber's signal, she inquires what number he wishes. Having learned this, she connects up the number desired and by means of a magneto calls the second subscriber to his telephone. When the conversation is completed, one of the subscribers notifies central by means of his magneto. The receiver hook must always be pulled down before ringing.

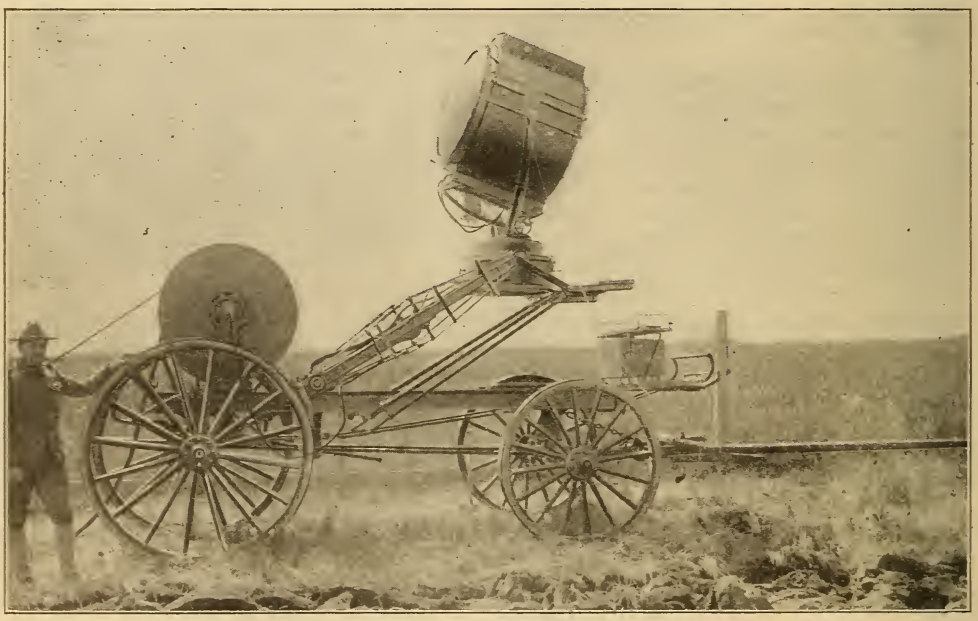
The system just described is called the local battery system. In the most recent practice, especially in larger cities, the local battery at the subscriber's end is done away with and so also is the magneto. A current to take the place of all the local batteries is furnished by a storage battery at the central station. This system is consequently called the central energy system.

In this system when a subscriber wishes to call up central, he has only to lift the receiver from its hook. This closes the circuit and lights up a small glow lamp on the switchboard in front of the operator. Central calls up the desired subscriber by means of an alternating current from her magneto, which in this case is a little power driven generator in the exchange. As soon as the subscriber replaces his receiver upon the hook the small glow lamp is out. This is, therefore, a notice for central to disconnect the two lines.

A new type of electric locomotive, of which twenty are in course of construction for the New York Central, will be capable of developing 4000 horse-power at high speed, the armatures of the motors being mounted directly upon the driving axles.

ELECTRICITY IN ARTILLERY OPERATION.

The recent reorganization of the United States Coast Artillery Corps has resulted in the adoption of many new electrical appliances. The picture herewith shows one of the portable searchlights with which our monster coast defense guns are equipped. These lights are not unlike those in use on men-o'-war, except that they are mounted on light-wheeled trucks and can be rapidly moved from one position to another. The generating plant is also portable, and can be put in operation almost instantly, as a gas engine is used to drive the dynamo.



ELECTRIC SEARCHLIGHT FOR ARTILLERY SERVICE

These lights are used to locate the enemy, both to direct the firing and to expose mined areas when the enemy is passing over them at night, so as to explode the mines at the proper moment. Searchlight drill, in which from one to three or more of these lights are used, is held at the forts at regular intervals. The drills are spectacular sights where two or more forts, with three lights each, are adjacent to one another, as is the case at some of our Atlantic and Pacific coast artillery districts.

The ranges of search and the commands during drills and in action are given by the battle commander from the secondary or fire commander's station by telephones, the lines being laid in underground cables, to the operator.

Telephone service at artillery posts is a most wonderful and intricate system. There are, generally, two or more of these systems, so that if one is disabled the other may be substituted. The big guns and mortars are sighted and fired by telephone instruction, the commands often being given from a point a mile or more away.

Another astonishing electrical invention used at the gun pits and fire command stations is a small instrument known as the telautograph. This contrivance will accurately reproduce the handwriting of the plotter or range finder, or of the battle commander, who may be a mile or more away from the gun pit, on a sheet before the gun commander in the pit. This machine is designed to record commands given in battle so there will be no opportunity for error, and is seldom used in drill work, owing to the telephone being so much quicker.

In the magazines surrounding the gun and mortar pits nothing save incandescent lights, heavily cased with wire screening, are used. Projectiles are handled by electric hoists and an electric signal system connects the interior of the magazine with the gun crew outside.

ELECTRICITY FROM WIND POWER.

The power of the wind, if it could all be used to advantage, would set at rest our fears concerning the exhaustion of the coal fields, but up to the present time very little has been done, comparatively speaking, to utilize this important force. Windmills, to be sure, are very commonly seen, but they are mostly used in a small way, on farms, for pumping water, grinding feed, etc.

The windmill, or wind turbine as it might be termed, has often been proposed as a prime mover to operate dynamos for the generation of electrical power. Experiments have been carried out along this line, notably in Denmark, and some successful working equipments have been built. Manufacturers of windmills in this country have also spent considerable time and money trying to develop the scheme, but their experience has been that, owing to certain difficulties of applying the power to the dynamo, the system is not a very economical one. The two main difficulties to be overcome in utilizing wind power are the uncertainty of the wind and the variation of its velocity when it is blowing.

Electric current for lighting purposes must be steady and its voltage must not rise and fall to any appreciable extent, or the lights will flicker. Since the voltage is directly dependent on the speed of the dynamo it will readily be seen that to maintain a constant voltage with a wind-driven dynamo, a more or less complicated governing device must be used. Then, too, as the wind will not blow when we want it to, we must provide a large storage battery to store up energy for use in periods of calm.

The problem of wind-generated electrical power is, however, an interesting one and will no doubt some day be satisfactorily solved. A recent installation at Willeston Green, London, England, though small, presents some interesting features. It furnishes current for 150 10-watt lamps and also for cooking and heating. The picture shows the windmill and governing devices.

On the wheel are two vanes or tail pieces which control the wheel and hold its face in a position relative to the direction of the wind such that the force exerted by the wind, and consequently the speed of the wheel, are practically constant at all times, regardless of the wind velocity.

It is asserted that by this arrangement the amount of power exerted by the wind upon the wheel can be kept within that required for the generator and thus enables the plant to look after itself in the strongest gales.

The electric generator is of two kilowatt capacity (about $2\frac{1}{2}$ horsepower). Its armature shaft is placed vertically and is driven

WINDMILL ELECTRIC PLANT

direct by means of a belt from a pulley placed at the bottom of the vertical shaft of the windmill. The control of the field circuit of the dynamo is maintained by resistances worked automatically.

ELECTRIC KITCHEN OF AN OCEAN LINER.

It is no small matter to attend to the feeding of the small army of passengers which demands attention during the trips of a large ocean liner. Early in June the "George Washington," the largest German steamship afloat, left the German Lloyd docks for New York City and it is stated that fully four thousand people were aboard this giant steamship.

Without the assistance of electricity it would be a hard task, indeed, to feed this army of travelers four and five times a day. The kitchen and storerooms of the "George Washington" are fully equipped with the very lastest electrical devices to make this

enormous task as easy and convenient as possible.

Many of these devices such as egg beaters, potato parers, mincing machines, automatic egg boilers, coffee mills and dish-washing machines are worked by electricity.

In addition to the kitchen there are on board ice houses for meats, bakeries, a confectionery room and scullery rooms. In all the kitchen and provision rooms occupy a space of 47,000 cubic feet.

The cold storage and provision rooms are so arranged that their contents may be readily sent into the kitchens by electrically operated dumb waiters.

USELESS WASTE OF POWER.

BY P. C. HENRY.

The Piedmont section of North and South Carolina is abundantly blessed with water power. The principal rivers abound with many shoals and valuable water power sites. Of late years, most of these valuable power sites have been bought by various companies. A few power sites are being developed; but the majority are still unused. In the course of the next decade, this section will certainly be crowded with factories—especially cotton, furniture and tobacco factories, on account of the cheap

USELESS WASTE OF 25 HORSEPOWER

power from the nearby rivers and immense raw materials at their doors.

Catawba County, N. C., resembles the Piedmont section in that it, too, has many and valuable shoals on all the creeks in the county. While these small falls are not as valuable as the shoals in the rivers, they are of late being bought for development.

Quite recently, the writer bought a valuable fall on a strong creek, five miles from a growing city, for $550.00, together with twelve acres of land and water rights to erect a 15-foot dam above the falls. The natural fall is 20 feet, which will give a working head of at least 35 feet, capable of generating 35 to 40 horsepower.

Many developments are being mapped out by which to use the energy of our Kenwood Falls. The first use will be a family laundry, as power, water and heat can be furnished in unlimited quantities and without cost. There will also be electric motor trucks to haul our goods to and from the nearby city.

The second development will be a creamery, in which the milk from the surrounding country will be worked into butter, and porkers fattened upon the by-products of the creamery.

The third improvement is to be an ice factory, to supply the daily needs of a growing city during eight months of the year. And with no rent, no taxes of any consequence, no water charges, no expense for power, no expense for drayage, it would be difficult to compete with us in supplying cheap ice for the inhabitants of two nearby cities.

The fourth development will probably be an overall factory, in which to use the surplus of our electrical energy. Located outside the city, labor can be secured at a minimum figure, raw material at the door, and power for the machines free of charge.

Years ago, every shoal on our creeks was used to grind corn; but as roller mills in the towns made their appearance, the small grist mills lapsed into decay. Now, however, a new use has been found for the power of every small waterfall, so it is reasonable to suppose that during the coming decade electrical energy will be produced at the majority of these shoals.

The electric vehicle is essentially the proper equipment for shopping trips; for the doctor who must depend upon a machine to be in readiness day or night, and which he can manipulate himself without fuss or bother and without calling upon a professional driver. The noiselessness and ease of control of the electric vehicle make it the perfect machine for ladies' use, and for threading through the busy city traffic the business man for his short trip finds it an especially agreeable mode of travel.

THE LOCOMOTIVE SEARCHLIGHT.

It is an inspiring sight at night to see a hundred ton locomotive go tearing across the country with a speed commensurate with its thousand horsepower and cutting the darkness with a beam of light which turns night into day for a mile ahead along the glistening rails. Or perhaps long before the sound of the train is heard or its whistle reaches our ears we see the glimmer of that spectre light reflected from the clouds.

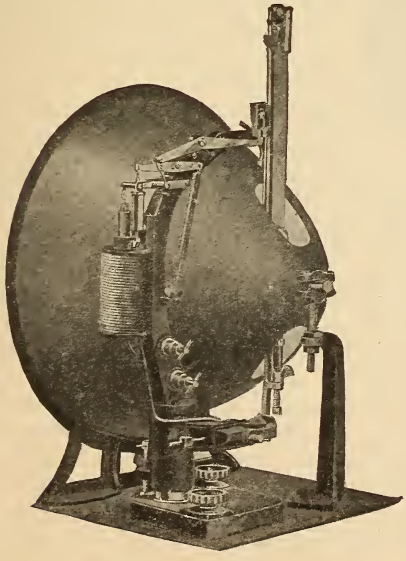
With the increased weight and speed of our modern trains came the necessity of more powerful headlights in order to light the way, for a heavy train going 70 miles an hour cannot be stopped in the same length of time that would suffice for the old time locomotive with its oil lamp and reflector. So of course electricity was again called upon and the result was the modern searchlight.

How is a locomotive searchlight operated, someone asks, and where does it get its current? This is accomplished in various ways, one method being by means of a little steam turbine on the locomotive which drives a dynamo for furnishing current to the arc lamp in the searchlight and also to a number of incandescent lamps for lighting the engineer's cab.

The turbine, though small, is of the latest pattern, the dynamo is a small compact affair, and the two are sometimes located just ahead of the smoke stack and at the back of the box containing the searchlight, or else at the rear of the sand box and whistle.

The searchlight is shown in one of the illustrations and contains various governing features, well known to electricians, which keep the two carbons of the arc at just the right distance apart for proper burning.

LIGHT AS DAY FOR A MILE AHEAD



ELECTRIC LOCOMOTIVE SEARCHLIGHT

THE MOTOR DISPLACES THE BELT.

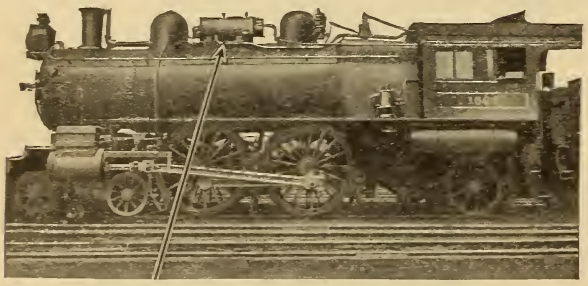
The first application of electric motors to machine tools was made a few years ago, although the idea was suggested by the late John Good, cordage manufacturer, as far back as 1893. In that year Mr. Good took out a patent for a cordage spinning machine driven by an attached electric motor.

Few persons outside of manufacturing employment realize to what extent electricity is now employed in the operation of machinery. Within the last decade it has been applied to machine tools, and the use of tools equipped with motors in big manufacturing plants of the country is growing so steadily as to warrant the assumption that it will at no distant day entirely supersede steam with its group and belt methods of driving machines. Within the last few years the textile manufacturers of the country have also thoroughly tested direct drive in that industry with the result that nearly every textile mill north and south is adopting motor drive for individual machines.

The economies of direct drive are easily seen. When the machines are idle they are using no power. There is no loss in power transmission, no loss in friction of belts, gears and shafting. The light is not obstructed with overhead shafting and connections nor is there any danger from flying belts and shaft ends. The power losses in shaft and belt transmission are considerable and are felt most in the coal bunkers, for it takes fuel to produce this wasted energy. With electric drive all the machines can be stopped but one or two, which use power only in proportion to the work they do, and the whole power plant does not have to run full blast to drive these few machines.

LIGHTING TRAINS WITH TURBINE DYNAMOS.

The lighting of railway trains has been an interesting problem to the lighting engineer since the first days of railroading, but it is only since trains traveled with sufficient smoothness to permit of reading on



SHOWING TURBINE DYNAMO ON LOCOMOTIVE

the cars that the electric lighting of steam trains has become a really important matter.

Various systems of electric train lighting have been used with varying degrees of success, embodying, as a rule, an electric dynamo driven from the car axle. One of the latest successful schemes, however, is to light the train from a steam turbine-driven dynamo mounted on the locomotive, which works in conjunction with a storage battery located on each car.

A small Curtis turbine dynamo is mounted on top of the boiler of the locomotive as shown in the cut. A turbine governor takes care of the speed variations caused by differences in boiler pressure, while a small voltage regulator acting on the dynamo field maintains constant voltage. This dynamo may be considered as taking care of the load and giving constant and steady illumination as long as the train is connected to the engine. To prepare for such times as the train is disconnected, each car is equipped with storage batteries which are charged by the dynamo on the engine during such time as the dynamo is not supplying current direct, for lighting the lamps.

There are also various automatic features for connecting and disconnecting the dynamo and batteries and the lighting circuit, involving simple devices known to electricians, such as relays, circuit breakers, etc.

PRECAUTIONARY AND FIRST AID SUGGESTIONS

BY DR. ROBERT GRIMSHAW.

At the last meeting of the Verband Deutscher Techniker in Germany, there was adopted, with the co-operation of the Imperial German Health Department, new text for the rules governing action in case of accident from electric current, a part of which is here given.

Independent of the sensitiveness of the human organism in the individual cases, it can be assumed as certain that the action of the electric current on the human system is in proportion to its strength. For this reason, conductors which are passing a high-tension current are more dangerous than those which distribute low tension current; because under similar circumstances they carry stronger currents. On the other hand, all possibilities must be avoided which reduce the total resistance of the body, and are thereby calculated to permit a strong current therein.

The current in the body is stronger, in proportion to the area and conductivity of the surface which is offered to the electricity at its entry into or passage from the system. In general, a current does not pass when only one part of the body touches an apparatus or conductor which is under tension, but the person otherwise is insulated as where the floor is dry and non-metallic or rubber shoes or very dry leather ones are worn, or the floor is of wood. In this case exit from the body is prevented. If the person in question is uninsulated, the current can pass through his body into the earth.

Moisture at the contacting portions of the body, as for instance damp hands, or

a damp floor, lessens the resistance of the body to the passage of the current, and increases the danger. A well-insulated workman can touch the conductor of a low-tension current or even grasp it with the whole hand without danger. If the insulation of the place on which one stands is not perfect, momentary touching of electrified parts is not necessarily risky; but if the conductor or part is grasped with the whole hand, it may be dangerous, as the entrance of the current is thereby much facilitated. There is increased danger where the contact does not take place with the hand, but indirectly by means of a metal tool held therein, for this conducts the current over the whole system and into the body. For this reason, where work must absolutely be done on current carrying conductors, the tools should have insulated handles.

If in case of an accident the injured one is still in electric contact with the conductor the first thing to do is to free him from contact therewith. In doing this, the following should be observed:

(1) Where possible, the conductor is to be put out of the circuit by means of the nearest switch, loosening the safety device for the line in question, or breaking the conductor by a dry non-metallic article, as for instance a piece of wood, a cane, or a rope thrown over the line.

(2) In doing this, those aiding should take care, in order to weaken the force of the current, to stand on a dry board, dry cloths, pieces of clothing, or other dry non-metallic substance, or to pull on rubber shoes.

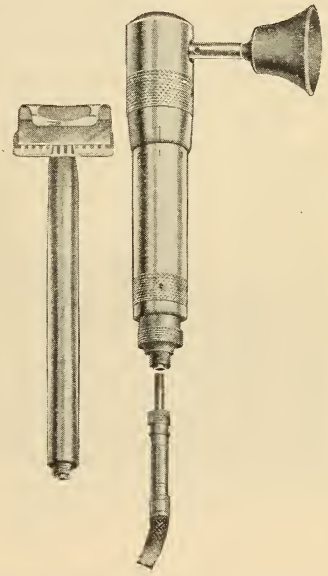
(3) The hands of the one coming to assistance should be insulated with rubber gloves, dry cloth, pieces of clothing, or other wrappings, and in rescuing the injured one he should not be brought in contact with metallic objects in the neighborhood.

(4) The injured person should be lifted from the floor and freed from the conductor. In doing this he is to be lifted by his clothes. One should especially avoid touching any uncovered part of his body. If the injured person is grasping the conductor, his grasp should be loosened, one finger at a time. Sometimes lifting the body from the ground is sufficient to break the current.

(5) The branches of electrical industry where a layman may come to the aid of an injured person are restricted to those in which the tension is not much over 500 volts. As a rule, street railway service keeps within these limits. Where, however, there is an accident from a high tension current, the first thing to do is to notify the nearest office of the plant in question, and to send for a doctor. As a rule, conductors and machines and apparatus for high tension current are marked with a danger signal.

ELECTRIC SHAVING OUTFIT.

Two or three years ago the electric shaving mug, which furnishes hot water for the morning shave in about a minute, was considered a novelty. Now it has become one of the regular utensils in the up-to-date electrical household and the manufacturers have, to use the popular expression, gone it one better, and have turned out an



ELECTRIC SHAVING OUTFIT

electric razor with vibrator attachment for an after-shave massage.

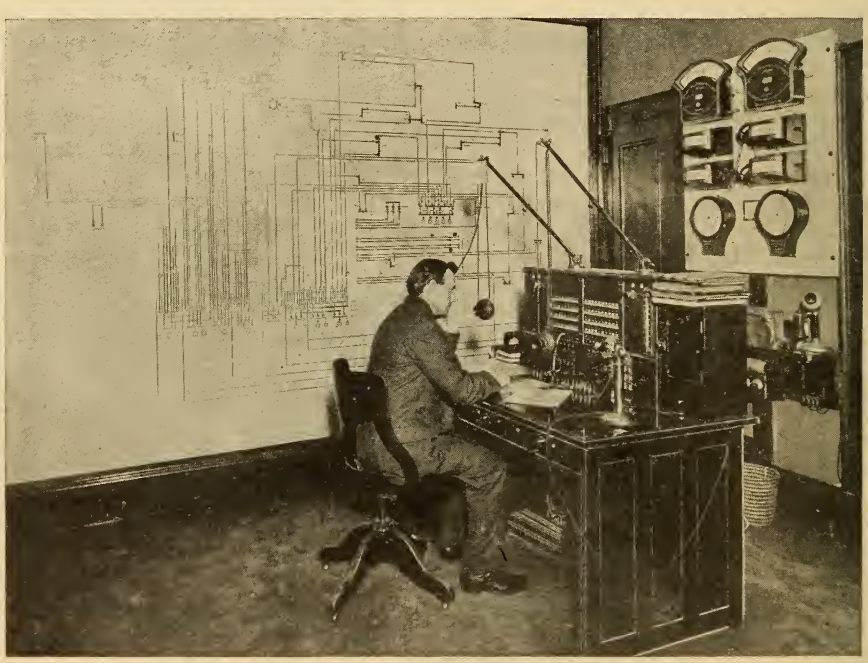
The razor is similar in appearance to the well known safety razor. It is attached to the vibrator shaft in a moment, and a rotary eccentric inside the razor handle gives the blade a vibratory movement which is said to greatly increase its efficiency. When through shaving detach the razor handle from the shaft and put on the vibrator attachment for a facial massage.

THE BRAIN OF AN ELECTRICAL SYSTEM

The electrical system of a great electric central station system such as that of the Commonwealth Edison Company of Chicago, for instance, is a veritable giant with a powerful heart and an intricate network of nerves. To properly control all the parts of this colossus and to harmonize them requires a centralized brain to direct this nervous system, says the Edison Round Table.

Such a brain center is found in the load dispatcher's office. The illustration shows the interior of this office with its two-position telephone board by which the load dispatcher can get into direct communication with all the stations and sub-stations connected with the company's system. He is thus in constant touch with every operating center. At the present time there are about 90 high tension lines carrying current at 9,000 volts and at 20,000 volts from Harrison, Fisk, and Quarry Street stations to nearly 50 sub-stations. There are also a number of lines connecting certain substations together for additional security. In this large network of transmission lines the closing of a wrong switch may result in a serious wreck, so the necessity for placing all authority and responsibility for switching in one man is apparent.

An indispensable aid in the ordering of this switching is provided on the wall adjacent to the telephone boards in the form of a large diagram of the transmission system. Every 9,000-volt generator and bus, every bus switch and line, and every substation bus and line switch is shown in its proper location on this diagram, and by means of pegs the position of each switch (open or closed) is indicated. All operators are under strict orders never to close or open a high voltage line or bus switch without direct orders from the load dispatcher and to report to him promptly whenever a line opens automatically. When a switch has been ordered closed or opened and report comes back from the operator that this has been done, a peg is immediately placed in or withdrawn from that switch in the diagram. At times of the day when the load reaches a certain amount the system is sectionalized, that is, it is divided so that part is carried by one set of gen-



THE LOAD DISPATCHER'S OFFICE IS THE BRAIN OF THE SYSTEM

erators and part by another set. This leaves many switches in the station and in a number of sub-stations so connected that the closing of them would tie these sections together. Such tying together cannot safely be done unless certain conditions exist and these conditions can be controlled only in the generating station. All such switches are thus danger points and are indicated as such on the diagram by pegs with conspicuous red tops. The pegs denoting closed switches have colored tops to indicate what operating section the line or bus is connected to.

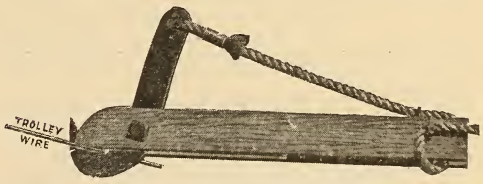
During serious system disturbance authorized members of the operating engineer's office assist the load dispatchers, of whom there are generally two on duty. During such disturbances two men take care of the telephoning, one in each position, another does the plugging on the diagram, while a fourth records on a small portable black board such important information as is called out to him by the men at the phones, such as load conditions, units damaged or put onto the system and similar information.

In a system as large as this it is frequently necessary to disconnect certain parts or apparatus for construction work, repairs or cleaning. In order that proper arrangements can be made safely for such work a system of "load dispatcher permits" was devised. Foremen or test engineers before being permitted to start work or tests on any part of the operating system must first make application for a permit stating clearly what it is proposed to do and what apparatus it will affect and when. Such application is sent for approval to a person authorized to assume this responsibility and, if approved, is forwarded to the load dispatcher. The latter makes the necessary arrangements so the application can be granted, unless operating conditions prevent. Such a system, while it may appear like red tape to the uninitiated, is absolutely essential to the safe performance of work on an extensive high voltage plant.

So much for the load dispatchers' functions with regard to their special duty of keeping the system "going." There is another side to their work which adds a welcome diversion—welcome if it comes not at an inopportune time. To many customers the load dispatchers are "the company," and to others an encyclopedia. Many humorous calls come in evenings, more humorous to the load dispatcher than to the caller, regarding the amount of last month's bill, the safety of certain wiring or the delays on certain construction jobs, and at times information is asked such as "the amperage of the street lights of Burlington, Iowa." The police and fire department also report to the load dispatchers any unsafe condition or damaged circuit which may come to their attention. In all of these calls the load dispatchers remember that during that conversation they are "the company". Police and firemen are thanked, kickers are pacified if at all possible and information is courteously given when possible. The load dispatchers are thus at times the kick receivers, again, the information bureau, or the trouble dispatchers, but at all times theirs are the guiding hands on the levers which keep the powerful giant in leash and subservient to their command, so that this, one of the greatest of central station systems in the world, will function properly and serve the city and its citizens with an efficiency and satisfaction of the highest order.

TROLLEY WIRE PICK-UP.

When a trolley wire breaks and lies squirming on the ground there is consternation. "Live wire!" everyone shouts and there is a general scampering from the vicinity. But the big power plant, perhaps



miles away, cannot be shut down because of a little frayed end way out on the system, so the next best thing to do is to tie up the wire out of danger till the damage can be repaired. A little device for doing this is known as the "trolley wire pick-up," which is shown in the cut. The handle is of wood so that the lineman or motorman can grasp the wire without danger of a shock. A light pull on the cord, a half turn of the cord around the handle, and the wire is safely in the grasp of the pick-up. Then the wire is pulled up by the cord and tied to a convenient pole or tree.

EXPERIMENTS WITH HIGH FREQUENCY CURRENTS.

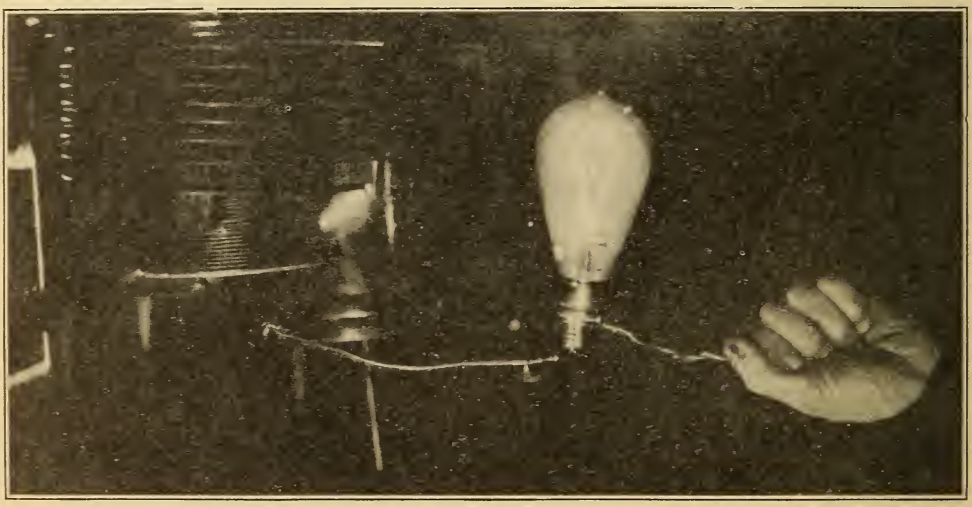
BY H. L. TRANSTROM.

It is generally conceded that the current necessary to produce death is 250 milliamperes, or one-fourth ampere. This is not always true, as some are killed by a fraction of this amount because of the difference of strength of constitution. Direct current produces the most certain death, but alternating currents of the commercial frequencies used, are the most painful. The ease by which alternating current can be changed from a low voltage to a higher one, makes it better suited for electrocution purposes.

Electricians are often heard to remark that they received a burn or shock from a circuit carrying several thousand amperes, the voltage being possibly only 220 to 500 volts. The reason they can withstand the shock is because of the high resistance of the body, and a circuit of large carrying capacity cannot force much more current through the body than a much smaller one if their voltage is the same.

Any electrician will tell you that a 110 volt 32 candle-power carbon filiament lamp consumes one ampere of current. The new tungsten lamp of the same candlepower consumes only one-third of an ampere, but is unsuited for high frequency work because the filament has too much inductance and is too fragile.

If a high frequency coil is constructed with the right proportions, and the condenser, transformer and spark-gap are adjusted to be in harmony, it is then possible to pass sufficient current through the body to light the 32 candle-power carbon filament lamp to full candle power, and even burn it out if desired without the slightest pain or inconvenience. Another remarkable thing about it is that only one wire is used, the body of the person being insulated in every way. The body acts as a plate of a condenser with widely separated plates, the body being one and the earth the other, the air being the dielectric.



LIGHTING A LAMP THROUGH THE BODY

The Tesla coil used for this purpose consists of a primary and secondary wound concentrically. The primary has eight turns of No. 4 copper wire wound eight inches in diameter, the adjacent turns being spaced apart one-fourth inch. The secondary has forty-three turns of No. 17 gutta-percha covered wire wound on a wooden cylinder five inches in diameter and five inches long. One end of the secondary is grounded to a water pipe. Only seven plates of the condenser described in the article in Popular Electricity, January, 1908, were used. The voltage on the primary in parallel was 160 volts, the frequency 60 cycles. I used a variable inductance in series with the primary to prevent the condenser spark from flaming, which would stop the oscillations. Turns Nos. 4 and 7 were the ones connected to the condenser and gap.

HOW TO DO ELECTROPLATING

BY J. R. WILSON.

PART II.

The first consideration in the plating process is the source of electric current. This may be either from a regular plating dynamo, or a set of battery cells. Of course if power is available and one can secure a plating dynamo it would be true economy, but the amateur may obtain good results with a battery.

PLATING BATTERIES.

Cells of either double liquid type or single liquid type may be used for plating. The best single liquid cell would be a "Smee cell" or modification of it which consists merely of two carbon plates with a zinc plate between them suspended from a wooden support in a jar containing a mixture of one part sulphuric acid to eight parts of water. The zincs must be kept well amalgamated. This cell when in action gives about 0.5 volt. If using this cell an addition of two ounces of chromic acid or bichromate of soda insures good steady current.

The Bunsen cell is the best type of double liquid cell to use. This consists of a glass jar containing a hollow zinc cylinder, slit on one side to allow free circulation of the solution. Within the cylinder stands a porous cup containing a bar of carbon. This cell is charged by well amalgamating the zinc cylinder inside and outside, and placing it in the jar. The porous cup with the carbon is then set inside the zinc cylinder. In the outer jar is placed a mixture of one part sulphuric acid to 10 or 12 parts of water (mixture should be cool before putting it in the cell), to cover the zinc or on a level with the liquid in the porous cup. The latter is simply nitric acid. Instead of sulphuric acid for the outer jar, battery salts can be purchased and added to the water. This avoids necessity of amalgamating the zinc, which is a troublesome job. The Bunsen type cell gives a good steady pressure of two volts.

The question now arises as to size of cell or number of cells and arrangement, to get the required current strength for different plating solutions. It is known, as stated farther on, that the various plating solutions offer different resistances to a current. It is also a rule that the surface area of the two elements (positive and negative) in a cell should each equal or exceed that of the anodes in the plating solution and the latter should always equal or slightly exceed the surface area to be plated. Following this rule out one will come very close to the required current for different plating solutions.

If one knows the amperage of his cells, however, or has the necessary apparatus to determine it, then the size or type of cell necessary for a given work is readily known. It must be stated here that the voltage for any certain type of cell is constant, regardless of the size. It also might be stated here that a double liquid cell as described has a 15 ampere hour capacity where the jar measures 9 x 6 x 8 inches.

For all plating work a low voltage with plenty of current is required. This means that the internal as well as the external resistance (or resistance through the entire circuit) must be kept low. Never more than eight volts is required in any plating.

In most cases a combination of cells must be used to get the desired voltage and amperage. By connecting two cells in parallel, that is carbon to carbon and zinc to zinc, the effect is that of using one cell twice as large, for twice as much current is obtained, though the voltage is the same. By connecting in series—zinc to carbon and zinc to carbon, the voltage is doubled but the current is the same as that of one cell.

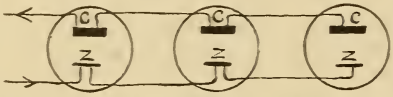
The following diagrams make this clear, taking a two-volt, four-ampere cell as an example. In using a combination of cells use all of one kind.

PLATING DYNAMO.

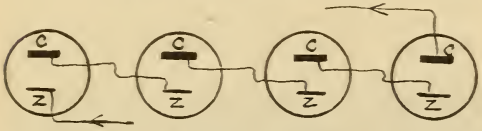
If a dynamo is used it must be a regular plating dynamo which differs in several respects from a lighting or power dynamo. The latter does not answer the purpose. A compound wound dynamo is preferable to a shunt wound. Install it securely on a foundation well insulated from the ground. It should be run by belt from a countershaft or in many cases where electric power is available, a direct connected motor is

used. These latter outfits can be purchased in one piece called a motor-generator outfit.

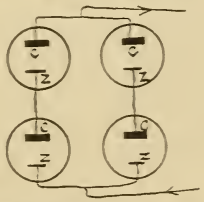
The capacity of a dynamo in volts and amperes is generally known, for a certain speed. Therefore if a dynamo is designed for a certain number of tanks, it is not



THREE CELLS IN PARALLEL GIVE TWO VOLTS AND TWELVE AMPERES



FOUR CELLS IN SERIES GIVE EIGHT VOLTS AND FOUR AMPERES



FOUR CELLS IN SERIES PARALLEL GIVE FOUR VOLTS AND EIGHT AMPERES

absolutely necessary to have a voltmeter and ammeter in the circuit. A rheostat must necessarily be installed at each tank to properly adjust the current for each tank according to the amount of work to be plated. It is more satisfactory however if a voltmeter and ammeter are inserted in the circuit. Rheostats of current carrying capacity sufficient to handle the current at each tank must be used.

ELECTRODEPOSITION

No two metals deposit under like conditions. Some metals require more current than others, some require higher voltage than others. But the chief consideration is not the voltage, but the amperage, because the quantity of metal that can be deposited in a good condition depends largely upon the number of amperes that can get through the plating solution. The strength (called density) of all plating solutions differs also as will be shown later on. Each metal has its own rate of deposit; for instance with a current of one ampere about 60 grains of silver is deposited in one hour on one-tenth of a square foot of surface while under the same conditions only 18.16 grains of copper or 16.9 grains of nickel can be deposited. This shows that silver deposits more readily than copper or nickel. The following table shows the comparative number of amperes

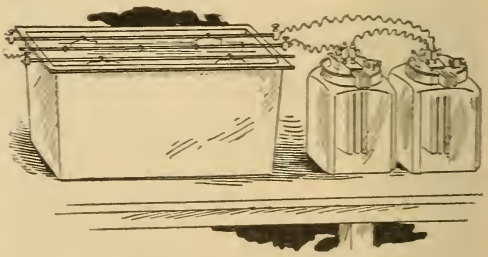
	Required Amp. per square foot	Voltage	Density of Plating Solution
Nickel	4	4	5 to 8° B
Silver	2	2-4	14 to 20° B
Cyanide Copper.	6-8	4	17-18° B
Duplex Copper.	10-12	4	15-20° B
Gold	1	2-4	

per square foot of plating surface and the density or strength of solution required for different metals.

PLATING TANKS.

For large work, especially in plating shops, the tanks are constructed of heavy two and three-inch timber firmly bolted and the inside lined with asphaltum. The preparation of this kind of tank would be unnecessary for small work. Enameled iron tanks or kettles, glazed earthenware jars or crocks, also glass jars such as those used for batteries are all suitable. Do not attempt to use bare iron.

It is safe to calculate that for each square foot of plating surface six gallons of plating solution is necessary. As most amateurs will not have a square foot of surface to plate at any one time much smaller receptacles can be used.



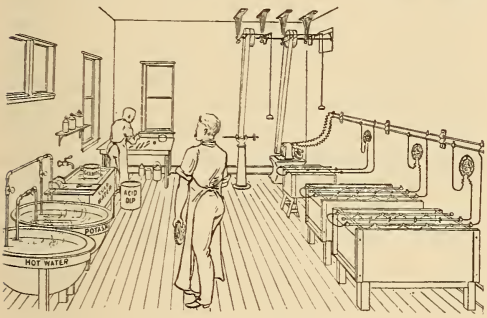
SMALL ELECTROPLATING TANK

The next thing to do is to convey the current from the cells or dynamo to the plating bath. The conductors must be large enough to carry the maximum current necessary to plate the full load of all the tanks. Resistance must be kept as low as possible. Consulting the following table the approximate size of wire may be obtained.

Number of Amperes	Diameter of Wire Required
3	.0625 inch
12	.125 "
27	.1875 "
49	.2500 "

The above figures hold for distances less than 40 feet.

Provide three rods for each tank, two anode rods and one cathode, or work rod, the latter lying between and parallel to the former across the top of the tank. These rods should be copper or brass and the same rule holds as with wire—get them large



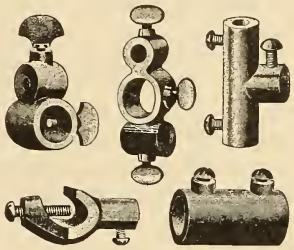
ARRANGEMENT OF THE ELECTROPLATING APPARATUS

enough. Connect the two anode rods at one end by a suitable conductor and then one of the other ends to the wire conductor from the positive terminal of the cell or dynamo. One end of the cathode rod connects with the conductor from the negative terminal. Of course where a dynamo is used the rheostats, etc., must be properly inserted. The circuit is now complete with the exception of the anodes, cathodes or work and the plating solution.

The anodes must be of the same metal that is to be deposited. These are supplied in all sizes by dealers in plater's materials. Suspend them from the anode rods by copper hooks (made by bending substantial copper wire into S-shape). The area of anode surface must be equal to or slightly exceed the surface to be plated and should extend slightly below the bottom of the latter. Maintain a distance of three to six inches between the anodes and cathodes.

The cathode or work to be plated properly prepared as described in Part I can now be suspended in the plating solution by copper wire.

Keep all connections bright and clean. When they become dull brighten them up with a piece of emery cloth. See that all connections are tight, loose connections give poor results. A few good rod connections are shown below.



FORMS OF CONNECTORS

To properly make up plating solutions one must have a book of litmus paper and a Baume hydrometer. The former is for testing the solution to find out if it is acid or alkaline. A strip of it dipped in the solution will turn red if solution is acid, but blue if alkaline. The hydrometer, as illustrated, is a graduated glass stem with a bulb filled with shot. When placed in liquids it floats and the heavier the liquid the nearer the surface the bulb will be. Thus in pure water the bulb will sink to such a depth that the zero mark will be level with the water surface. If salts or anything else is dissolved in the water, thus increasing the density of the solution, the bulb rises and gives a different reading on the stem. Copper, nickel and silver are usually the amateur platers' metals because they as a rule deposit more easily and in a better condition than most other metals. These metals will be considered in the order named.

HYDROMETER

COPPER-PLATING SOLUTIONS.

There are two copper plating solutions, namely cyanide solution and duplex or acid solution. Now it may puzzle the amateur as to which one he ought to use. Let it be made plain here that with iron or steel objects the cyanide solution must be used; with other metals it makes no difference which is used. In fact the duplex solution is easier to keep in working condition and hence is used more extensively. The duplex solution may be used on iron or steel if the

latter is first plated for five to ten minutes in the cyanide solution (until it gets a good covering of copper), rinsed in clear water to remove all cyanide and then placed in the duplex solution.

Taking up the cyanide solution first weigh out the following:

Carbonate of Copper, 5 oz.
" " Potash, 2 oz.
Cyanide " " 10 oz.
} To each gallon of water

Dissolve the cyanide of potash in a portion of water and add the carbonate of copper previously dissolved in a portion of the, water, then add the carbonate of potash, also previously dissolved; slowly stirring until thoroughly mixed. Add this to the rest of the water and stir until completely dissolved. The density of this solution should be between 15 and 20° B. (tested with the Baum hydrometer). If it is below 15°, more salts in the proportion given above and previously dissolved must be added until it is correct. If it is too strong—above 20° B.—dilute with water.

Instead of using carbonate of potash a great many platers use a little ammonia, as this keeps the solution clear.

Now suspend a piece of work from the work rod in the solution for a test. When the circuit is closed a smooth, even coat will be deposited almost immediately if all conditions are correct. The following conditions may occur:

1. No copper is deposited though bubbles come from the object to be plated. There is too much cyanide in the solution in this case and a little carbonate of copper dissolved with some cyanide of potash in water if added to the solution will start the deposition again.

2. The anodes become covered with a green coating. This shows that the cyanide in the solution is being used up. In this case cyanide of potash (dissolved in water) added slowly with constant stirring, will dissolve the green coating and plating will resume. Be careful not to add too much cyanide, however, as condition number one will occur. Just enough to cause the green coating to disappear is sufficient.

Twenty minutes will give a good coat of copper. As said before the object can be left in this bath for only five to ten minutes to give it a fair coat (called strike) and then transferred to the duplex solution. Be sure to get it well covered in the strike or the duplex will eat it off.

The duplex copper solution is made by simply dissolving 12 ounces of copper sulphate crystals to the gallon of water and then adding a little sulphuric acid. If it is too acid the deposit will be streaked. This is remedied by adding some carbonate of copper or even a little ammonia, though not enough to change red litmus to blue. Then test with the hydrometer. This should stand between 17 and 18° B. If below 17° B., add more copper sulphate. If higher than 18° dilute with water. When the solution is correct, immerse a piece of work and test. This should immediately give a good deposit, with moderate evolution of gas at the work. Be sure not to attempt to plate on iron or steel without having first "struck" it in the cyanide bath.

As brass is in such close relation to copper (a mixture of copper and zinc) it may be added here that a good brass plating solution is made by using the cyanide of copper formula and adding carbonate of zinc (5 ounces to each gallon of solution). Of course brass anodes previously annealed must then be used in place of copper anodes.

NICKEL PLATING.

There is only one good nickel plating solution and this is made as follows: Dissolve by boiling, 14 to 16 ounces of sulphate of nickel and ammonia (ask for double salt of nickel when purchasing) per gallon of water in a clean stone jar. When it is all dissolved and cool, test with the hydrometer. This solution should be worked at 5° to 8° B. If lower than 5° B. it is too weak and more salt previously dissolved as above must be added till correct. If higher than 8° B. dilute with water. Nickel solution should always be slightly acid. If, on testing with litmus, it is alkaline add just enough sulphuric acid to just turn the litmus red. If too acid, add a little ammonia. Remember that all solutions need adjusting now and then and it is best to test them a few hours before use so that if they do require doctoring they will have a few hours to stand before again using.

On immersing a piece of work in the bath and the current turned on, a thin white coat of nickel should be deposited in two or three minutes with bubbles rising slowly from the work. If too much bubbling occurs and the work is instantly covered with a thick white deposit which soon turns to a dull gray or black, the current is too

strong and the work is being burned. The current must be reduced by taking off a cell, or more work may be placed in the tank.

If no deposit occurs in three minutes, and yet the work turns dark, the current is too weak and either the current must be increased or some work taken out of the bath. A good thick deposit should be obtained in 20 minutes on brass but for iron it requires from 45 minutes up. If the anodes are dirty or if the anode surface is too small, the nickel is not likely to deposit.

Nickel deposits much better if the articles are first "struck" in the cyanide copper bath for five minutes, rinsed and then placed in the nickel bath.

SILVER PLATING SOLUTIONS.

The standard silver solution used by most platers is chloride of silver dissolved in cyanide of potash. Purchase the silver chloride from a dealer in plater's supplies and make up the solution as follows:

Silver Chloride	2 oz.
Cyanide of Potash	12 oz.
Water	1 gal.

Rub up the silver chloride to a thin paste with water and having dissolved the cyanide in the gallon of water add the paste to the latter. Stir till all is dissolved. It is advantageous to filter this bath before using, and remember to keep the solution away from the light as much as possible. Light decomposes silver salts. This solution should be anywhere between 14° and 20° B.

The main thing in working a silver bath is to keep the proper proportions between the silver, the cyanide and the current. This can only be accomplished—and this is true with all plating solutions—after the operator has had experience with his solutions and can judge by the appearance of his work.

If there is not sufficient free cyanide the anodes become coated more or less with a dark slimy deposit of silver oxide and the work instead of receiving a dull white deposit assumes a bluish color.

An excess of free cyanide will be shown when the anodes become white and frosty while plating, whereas they should become gray when the current is on; and the deposit is soft and spongy which when buffing later will strip off. Silver chloride rubbed to a thin paste with water should be added or the anode surface may be increased. Precaution must be taken, however, to test the strength with the hydrometer for if it is too dense (greater than 20°) no salts should be added, but water, to lower its density.

The best way to plate with silver is to first run the work in nickel or copper solution for 20 minutes to give a good plate and after rinsing transfer immediately to a silver "strike" solution for a few seconds and then to the regular silver solution for 15 minutes or more. The reason for this is that silver will plate better over copper or nickel; preferably the latter.

A silver "strike" solution is the same solution as the regular silver except that it must be stronger (about 24° B.).

BUFFING.

The article being plated, remove it, slightly swishing it in the solution first, and rinse in hot water and place it in a box of sawdust, covering it up well. The sawdust should be of some hard wood and, if it can be arranged, kept warm to expel the moisture. Brush the sawdust off with a soft brush and take to the buffing wheel.

Cotton buffs, made of disks of muslin or cotton flannel, must be used for buffing plated articles. The hardest buffs which are best for nickel buffing are made in sections stitched or quilted together, while the softer buffs are stitched only at the centre. Run the work on the buffs the same as was done in polishing before plating, using a suitable buffing compound, which must be applied to the wheel now and then. For silver use fine red rouge composition occasionally dipped in kerosene. For copper and nickel use white Diamond or Acme. These come in stick form.

STRIPPING.

Occasionally, and probably quite often with amateurs, it is desired to replate old articles. The old plate must first be entirely removed and the surface prepared as perfectly as with articles that have never been plated.

Nickel plate is stripped by immersing the article attached to a stout wire in a stoneware jar containing a mixture composed of one pint of water, one pint of strong nitric acid and four pints of strong sulphuric acid. Add the sulphuric acid to the water and when cool add the nitric acid in making this mixture. Keep the article in motion all the time and watch closely, for as soon as the plate is removed take the article out and rinse thoroughly. If the plate is not entirely removed do not replace it in

the solution before thoroughly drying (the dip must not become further diluted).

Silver plate may be removed by performing the above operation only using a cold mixture of one part strong nitric acid and ten parts of sulphuric acid. Hot sulphuric acid to which a few crystals of saltpetre are added may be substituted for the above.

A few hints are all that is necessary now.

Use only chemically pure salts in plating solutions.

Always dissolve any salts before adding them to the bath.

Remember that potassium cyanide is a deadly poison.

Have a place for all materials and keep everything in its place. All salts (cyanide, copper sulphate, etc.) ought to be kept in wide mouth bottles on shelves.

It is best to make all plating solutions up hot; salts dissolve more readily in hot solution.

The temperature of plating solutions should not fall below 60° F.

The current for a specified amount of work to be plated, must not be turned on until all the work is in the bath or burning will result. Or if desired an anode may be hung on the cathode rod on each side of the work until all the work is in.

Instead of buffing small articles such as pins, cuff buttons, etc., place them in a canvas bag with good dry boxwood sawdust and attaching one end to the wall or any support shake the bag vigorously. The articles will become nicely polished. They can then be rubbed with a chamois and rouge if desired.

DRILLING TRACK RAILS.

In the construction of electric railway tracks when the rails have been laid and bolted together it is necessary to drill holes through the web of the rail for inserting the ends of some types of rail bonds. These bonds are pieces of copper cable or very heavy copper wire for joining the two abutting rails, in order that the electric current, after it has passed from the trolley wire through the car motors to the rail, may find an easy path around the hundreds of rail joints and so back to the power plant.

The task of drilling these holes for the reception of the bond terminals, either in new track or where old track is being rebonded is a very laborious one if performed by hand, so now electric drills are largely used for the purpose. They consist of a motor with one end of the shaft projecting on which is a chuck to hold the drill. On the opposite end of the motor is a screw

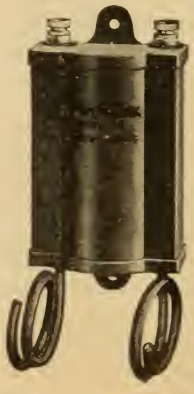
ELECTRIC RAIL DRILL

feed operated by the hand. A "U" shaped piece of steel grips the rail on the opposite side from the drill and also furnishes a shoulder against which the feed screw bears. Turning the feed screw forces the drill through the rail.

A wire cable, hooked over the trolley wire brings current to the motor, the return current being through the rails as in a car motor.

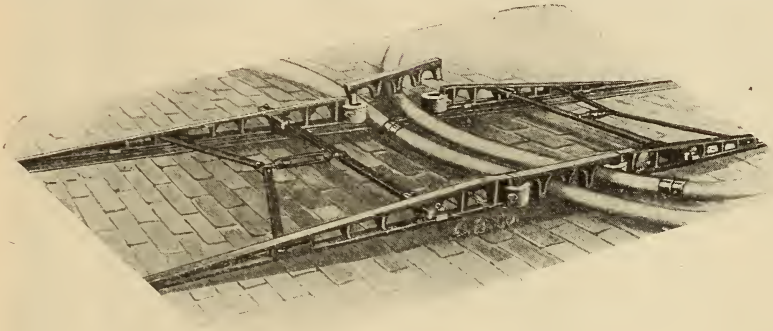
RINGING DOORBELL FROM LIGHTING CIRCUIT.

How often the question is asked: "How can I ring my doorbell from the lighting current instead of from batteries?" If your lighting current is alternating, and nine times out of ten it is, you may do this very readily. A small transformer is made for this purpose, as shown in the cut. It takes the ordinary 110-volt current and reduces it to the right amount to ring the bell. These transformers take so little current that they will not register on a watt-meter, consequently the expense for operation is nothing.



HOSE BRIDGE.

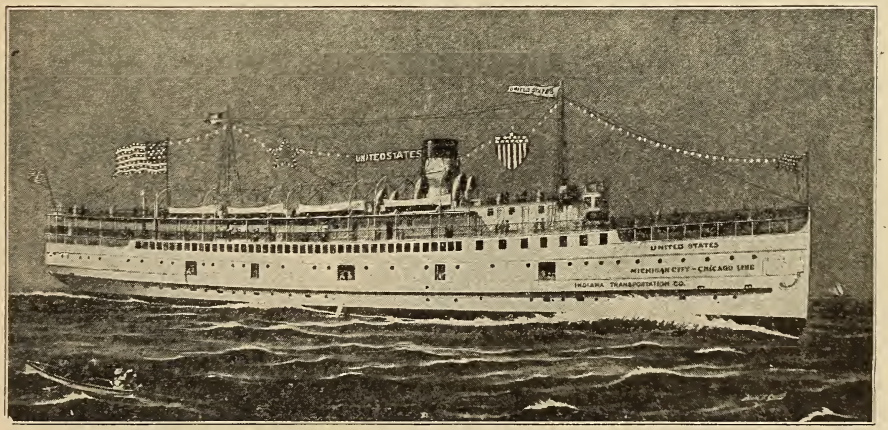
Street car traffic is often tied up for a long time during a fire because of the fire hose stretched over the track. Up-to-date railway companies now provide their "trouble wagons" with emergency hose bridges, and some fire departments use them. They are easily put down on the track rails in a manner shown in the cut and then locked together. This furnishes a slightly inclined path, and the car wheels following this path pass over the hose without cutting it.



HOSE BRIDGE

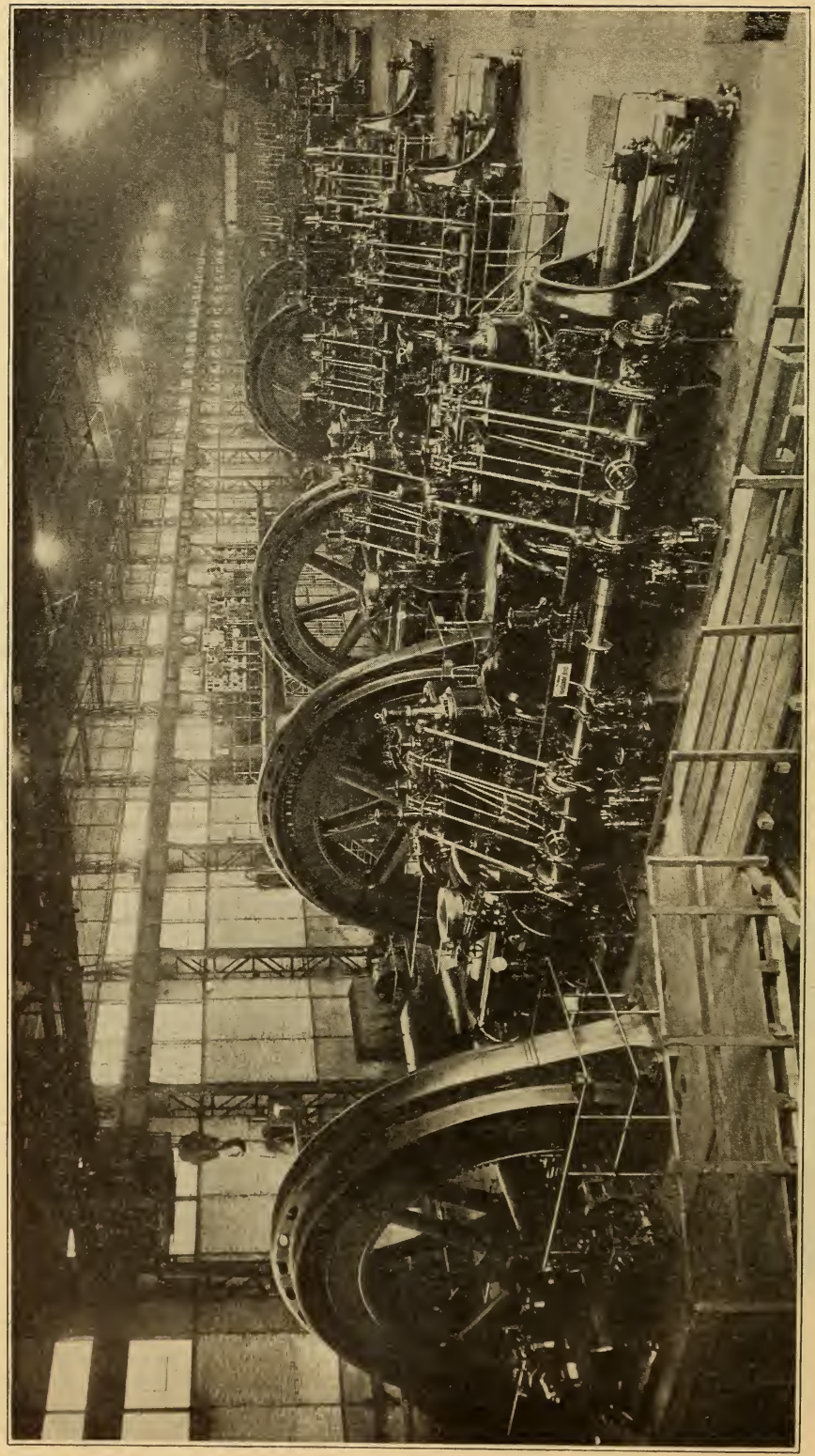
NEW LAKE STEAMER BRILLIANTLY LIGHTED.

Chief among the novel and interesting features of the new steel lake steamer "United States," which recently went into commission on Lake Michigan, is its electrical equipment. Residents along the lake shore will be afforded a marvelous sight this summer as this new vessel proceeds along its way. In addition to the regular lighting, it bears an immense shield decorated with red, white and blue lamps, a large skeleton star outlined with electric lights and a huge double face electric sign reading "United States." This sign flashes the name of the vessel first on one side and then on the other. The crowning feature is an Old Glory flag erected on the stern. It is constructed entirely of metal and is studded with red, white and blue electric lights which are arranged with a flasher giving the effect of a waving flag. To see the Stars and Stripes waving at night miles out on the lake will be, to say the least, an unusual sight. The flag, star, name-sign and shield are connected with festoons in the three colors extending from the masts.



LAKE STEAMER ELECTRICALLY DECORATED

The "United States" is 215 feet in length, 40 feet beam and to the top of the bridge measures 56 feet. It is equipped with the latest wireless telegraph apparatus.



GAS ENGINE ELECTRIC GENERATING STATION

MAKING ELECTRICITY BY GAS ENGINE POWER.

The gas engine is becoming a very lusty young competitor of the steam engine and the latter can no longer be "exclusive" as in days gone by, but is obliged to get out and hustle to maintain its dignified position, even with the assistance of its latest development, the steam turbine. In the last two or three years there have been built some very large power plants for the generation of electricity by gas engine power, both in this country and abroad, and where blast furnace gases are available it has a distinct economic advantage, for these gases were before a waste product.

One large German gas engine electric plant is that of the great iron and steel works in Haspe, and an interesting interior view is shown on the opposite page. There are five of these monster gas engines, each driving an alternating current dynamo having a capacity of 1,100 kilowatts or nearly 1,500 horsepower.

UNIQUE ELECTRIC TRUCK.

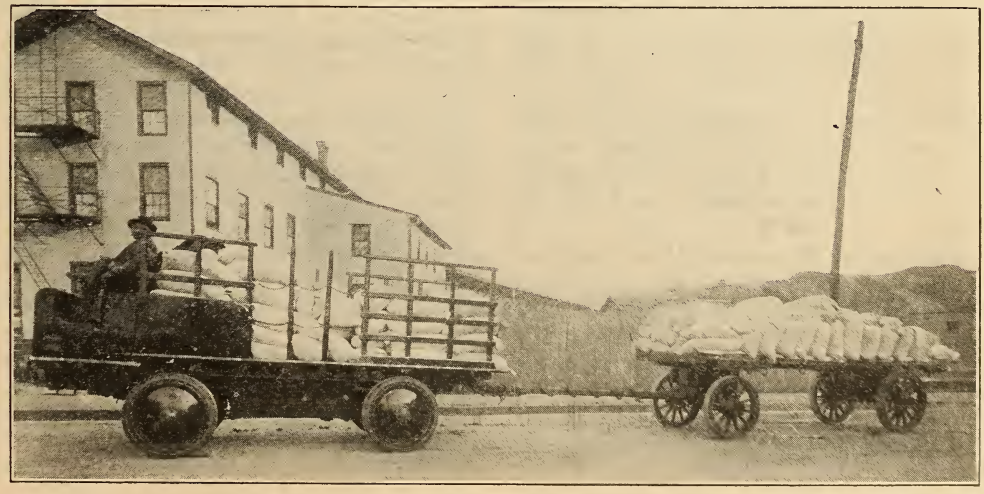
Expense and annoyance of maintaining friction clutches, reverse and sliding gears, and counter shaft sprockets and chains on gasolene trucks are well known. On the other hand the electric truck has a limited range of action owing to the necessity of recharging the storage batteries, and the latter also represent a large dead weight. A combination of the two therefore suggested itself, eliminating these disadvantages. The illustration shows a unique "gaso-electric" truck embodying such a combination.

On this truck there is a four-cylinder gasolene engine which drives a dynamo. This dynamo in turn generates electric current for the motors which operate the truck. This does away with the storage battery; it gives the advantages of electric control with practically no mechanical complications, and at the same time provides for an unlimited range of travel. The motors are located within the wheels themselves and apply the power directly to the rims of the wheels. This is done by mounting each motor rigidly on the end of the truck axle and extending the motor shaft in each direction out to the wheel rim. Here pinions on the motor shaft engage cogs on the wheel rim, and as the motor shaft turns, it exerts a "couple action"; that is, pushes the wheel forward at the top and pulls backward at the bottom.

The truck shown will carry a load of five tons and at the same time draw a trailer with another five ton load.

ELECTRIC SCALES

The customs authorities are trying out a plan to prevent fraudulent weighing of merchandise on the piers, by means of electrical scales. The new system involves the installation of electric dials in the custom house which will be connected with the weighing machines on the docks by wires.



ELECTRIC TRUCK WITH MOTORS IN THE WHEELS

POPULAR ELECTRICITY WIRELESS CLUB

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine is devoted to the interests of the Club and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments.

SPARK COIL CONSTRUCTION AND OPERATION

BY V. H. LAUGHTER.

PART III.

ASSEMBLING AND MOUNTING.

One of the double sections is now taken from the linseed oil and laid flat on its face on a table or smooth surface. Directly on top of this section are placed four sheets of the filter paper. The filter paper should be placed so that it fits neatly over the surface of the wound section. It is pressed down with a moderately warm smoothing iron.

The next double section is placed on top of the first and the exposed end terminals of the two double sections connected together by twisting and adding a drop of solder. The total number of double sections are assembled in this manner. However, care should be used in assembling the sections to connect them so that the current will flow continuously in one direction around the completed coil. In Fig. 9 is shown the plan to be followed out in assembling. (A), (B) and (C) represent the respective double sections and (D) the core.

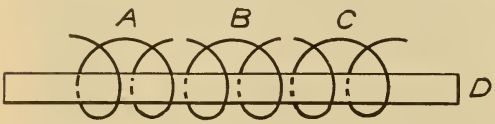


FIG. 9. MANNER OF CONNECTING DOUBLE SECTIONS

When all of the sections have been assembled the insulating tube should be run through the center. The sections are now run up the tube until the ends of the two end sections are at equal distances from the ends of the insulating tube. The primary winding and core are run through the center of the insulating tube. This completes the work on the core, primary and secondary. The next work in view is to mount these parts in a suitable case.

THE CASE.

In the Ruhmkorff type of coil the primary and secondary windings are mounted on top of a base with vibrator and binding posts, the base underneath containing the condenser. This type of mounting gives a very finished and near appearance to the coil but it requires delicate handling in building, and places the parts where they are liable to get damaged. For general all-around use in the amateur's laboratory, the coil should be so built that the delicate parts will not be exposed, and stand an ordinary amount of rough usage. This can be best accomplished by mounting the parts, with the exception of the vibrator, in a suitable case. In fact this method is now generally employed in all the most efficient types of spark coils.

The case for the size coil given here should measure five inches in width, five inches in depth, and ten inches long. This will allow one-half inch space between the secondary and the sides. The base on which the case is mounted should measure 14 inches long by six inches wide. Around this base is built up a second small case which should be about one and one-half inches deep. In this bottom case the condenser is mounted, although this should not be done until the coil has been put into actual use and the exact amount of condenser capacity to use actually determined.

In Fig. 10 are shown the four sides of the coil case and the plan which should be followed out in grooving. Although it is not absolutely essential that the corners should be grooved, this will make the case more rigid and give it a workman-like appearance. The dimensions as shown in Fig. 10 are for the inside measurements, as any thickness of board from one-fourth inch to one-half inch can be used for the

building up. Therefore for building up the case will be needed: Two boards (C) (C) measuring five inches wide and 10 inches long, the end pieces (A) (B) measuring five inches by five inches, and the base (D)

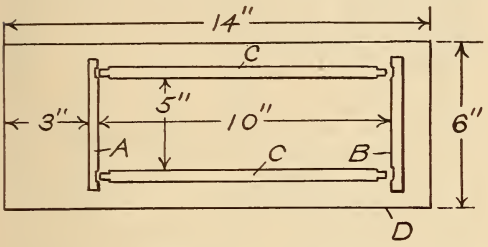


FIG. 10. MANNER OF ASSEMBLING CASE

measuring six inches wide by 14 inches long. The ends (A) and (B) however should be drilled with the holes one and one-eighth inch in diameter as shown in Fig. 11; the hole in (A) being drilled all the way through and in (B) countersunk to a distance of half the entire thickness, i. e., if the piece

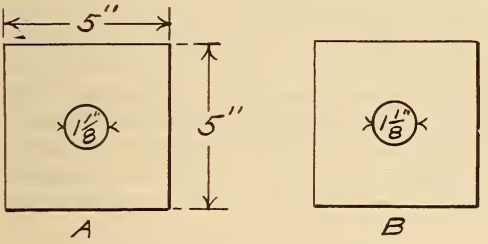


FIG. 11. END PIECE DIMENSIONS

(B) is one-half inch thick the hole should be countersunk one-fourth inch deep.

Around the baseboard is built up a second containing case one and one-half inches deep for the condenser.

The parts of the case are now all assembled, preferably by screwing down with small screws, leaving out however the end piece (A). As shown in Fig. 10 the end (A) should rest, when assembled, three inches from the end of the base (D).

The next operation is to mount the core, primary, and secondary, in the case. Place the whole in the case and let the core end rest in the one and one-eighth-inch countersunk hole in (B) and bring the piece (A) in position so that the core protrudes one-fourth to three-eighths inch through the hole.

Screw (A) up tightly, which will leave the complete parts supported in the case by the ends of the core. Before this mounting operation, however, two holes should be drilled in the base (D), directly under the primary terminals, and the primary terminals led through into the bottom case. To the secondary terminals are next connected and soldered two short leads of No. 22 single silk covered copper wire. This is done in order to prevent handling of the delicate secondary wires.

About four pounds of paraffine and beeswax in the proportions of half and half are now placed in the boiling can. When the solution has reached the boiling state, hold the secondary leads straight up from the center of the secondary and pour the boiling mixture into the case. Pour quickly and evenly as possible. It is evident that the corners of the case should fit tightly, or otherwise the boiling mixture will run out. The mounted primary and secondary is now set aside until the solution "sets," and in the meantime work will be taken up on the vibrator.

THE VIBRATOR.

In Part I we learned that the purpose of the vibrator was to "make and break" the current flowing through the primary winding and thereby induce a current of several thousand volts in the secondary turns. The efficiency of the vibrator plays a very important part in relation to the spark length. No matter how well the coil is constructed, if the vibrator is of poor design the spark will fall far below the calculated length.

In a vibrator it is essential that at each "make," or closing of the circuit sufficient time must be allowed for the current to flow around the primary winding and fully saturate the core with magnetism, and when this point is reached make a sudden break. Unless this cycle is accomplished properly, the spark will be weak and stringy, owing to the fact that sufficient time is not allowed at the "make," for the core to become energized, and the "break" is of such duration that magnetic effects will leak or become dampened. To overcome these difficulties a vibrator of the following type should be used.

The complete vibrator mounted on the base is shown in Fig. 12. (M) represents the end of the core projecting through the end of the coil case. The vibrator proper comprises the soft iron disk (K), the regulating screw (L), the spring brass strips

(J) and (I), the brass base (D), the brass pieces (E) and (F), the screws (N) and (O), the metal supporting post (B) and thumb

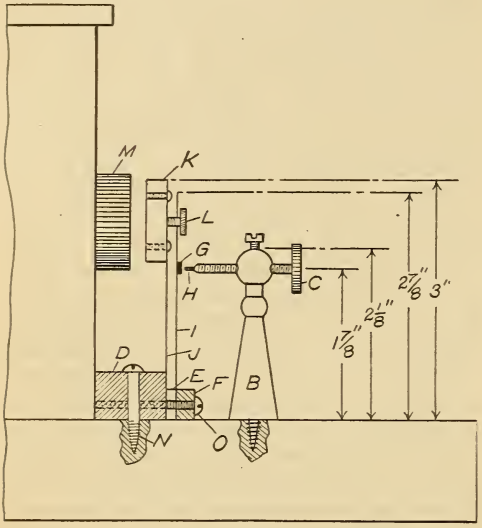


FIG. 12. THE VIBRATOR COMPLETE

screw (C) with platinum contact (H) in the end.

To begin the construction first get a brass block made up according to Fig. 13. This is the block as shown at (D) Fig. 12. Two one-eighth inch holes (O, O) are drilled through the block three-eighths inch from each end. A third hole three-sixteenths inch in diameter is drilled through the top for the insertion of the screw (N). (See Fig. 12). The two brass blocks (E) and (F) (Fig. 12) are next made up. (E) should measure one-eighth inch thick, one-fourth inch high and one and one-fourth inches long. (F) has the same dimensions with the exception it has a thickness of three-sixteenths inch. Holes are drilled through blocks (E) and (F) three-eighths inch from each end so that a screw can be run through and will engage the threads at (O) in the block (D).

The spring brass strips (J) and (I) are now prepared. (J) should measure three inches high, one inch wide and 1-32 inch thick. The top is rounded off as shown in Fig. 14. Holes one-eighth inch in diameter (O, O) are drilled through, three-sixteenths inch from the bottom and one-fourth inch from the edges. The hole (P′) is drilled through the center three sixteenths inch from the top, and (P^2) is seven-eighths inch from the top. The hole (W) is one-half inch from the top. Each of these holes should be one-eighth inch in diameter although this is not essential, as the size can be made to conform with screws on hand.

The spring (I) measures $2\frac{7}{8}$ inches in length by one inch wide and about 1-64

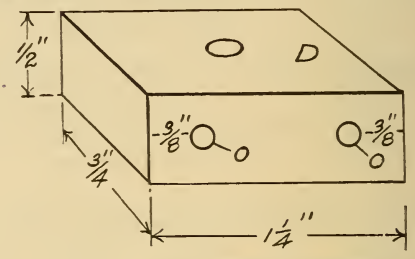


FIG. 13. VIBRATOR SUPPORT

inch thick. This spring is drilled with holes at the bottom the same as the spring (J) and a 1-16 inch hole is drilled at (G) (Fig. 12) and a one-eighth inch hole at (L). At (G) a small platinum button is fixed. This button should measure one-eighth inch in diameter by one-sixteenth inch thick, and as it usually has a small projecting tip, it will only be necessary to insert this tip in the hole and head down. The soft iron disk (K) should measure one inch in diameter by one-fourth inch thick, drilled and threaded as shown in Fig. 12. The brass standard at (B) need not be of the same style as

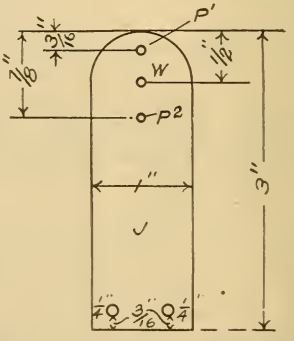


FIG. 14. SPRING BRASS STRIP

shown but it is obvious that it should be threaded for insertion of thumb screw (C) at the indicated height, and be made quite heavy to lessen the vibration.

The thumb screw (C) can be of any convenient length or size with a hole for the insertion of a bit of No. 16 platinum wire in the end.

In assembling, first the brass block (D) is screwed down to the base by means of

the screw (N). The soft iron disk is screwed to the top of the spring brass strip (J), and the strip (I) loosely screwed to (J) by means of the screw (L).

These parts are now mounted on the brass block (D) by means of the blocks (E) and (F) and the screw (O). The standard (B) and screw (C) are mounted so that the platinum tip at (H) will rest directly in the center of the button (G).

This completes work on the vibrator and the cycle of operation is as follows: The primary circuit is completed through the points at (G) and (H) which allows the current to circulate through the primary winding and energize the core. The core now attracts the disk (K). The disk in its forward move pulls the head of the screw (L) against the spring (I) and quickly breaks the contacts (G) and (H). The current now ceases to flow and the magnetic pull dies down. This allows the disk to fly back, which again closes the circuit at (G) and (H). The disk, however, in its backward move goes back a considerable distance, as the screw (L) works loosely through the hole drilled in (I), and during this backward swing the circuit is closed at (G) and (H), this gives the long "make." The head of the screw (L) in its forward movement is brought against the spring (I) which gives a sharp and quick "break" at the contacts. Thus, this vibrator fulfills the conditions of a long "make" and quick "break."

The cover of the coil case is made with two binding posts to which the secondary terminals are connected.

Binding posts are also mounted on the base near the vibrator to which the primary terminals are connected.

In Fig. 15 is shown the complete coil, partly in cross-section. For connections refer to the wiring diagram of a spark coil as shown in Fig. 1, in Part I of this series.

ADJUSTMENT.

Considering that the coil has been built up as shown, the final adjusting will be taken up. First see that all connections are properly made and connect 10 dry cells in series with the primary binding post and a common telegraph key. Connect the condensers across the vibrator contacts, having all the capacity thrown in the circuit. Press the key and turn the screw (C) up until the point tips the contact on the brass spring. This will close the circuit and start the cycle of vibration. To begin with, have the secondary terminals separated about one inch and gradually draw apart as the adjustment is continued. Vary the tension of the screw (L), the thumb screw (C) and the condenser capacity until the maximum spark length is the result. This will require time and care, but each adjustment will become easier as we will have our previously learned points to draw from. Considering that right adjustment of the vibrator is made, and the proper amount of condenser capacity has been thrown in the circuit, the spark will jump a full three to four inches across the gap. The complete parts necessary will not cost over $12.00 when completed.

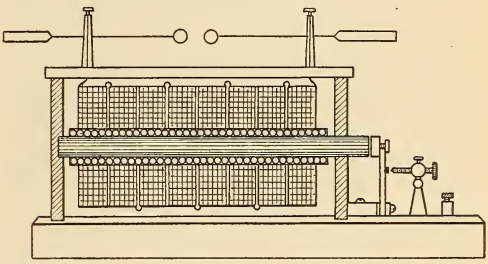


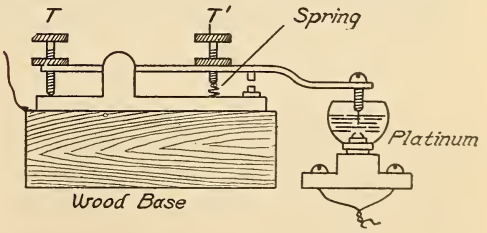
FIG. 15. ARRANGEMENT OF PARTS OF SPARK COIL

(To be continued.)

SENSITIVE DETECTOR.

The advantage of this bare point detector is that the platinum point does not turn as it enters the liquid, as in most detectors of this type, but moves in a vertical direction, and so can easily be adjusted with more accuracy.

A telegraph key is mounted on a wood base. The switch and knob are removed.



SENSITIVE DETECTOR

A screw is inserted in the end of the key, to which is fastened the platinum point, which consists of a piece of wollaston wire

0.0001 inch in diameter. When (T) is turned the platinum point is raised or lowered. The tension on the spring is regulated by turning (T'). The receptacle for the liquid is made by breaking off the top of the bulb of a miniature lamp. Connect both terminals of the lamp together.

BENJAMIN RONSLIN.

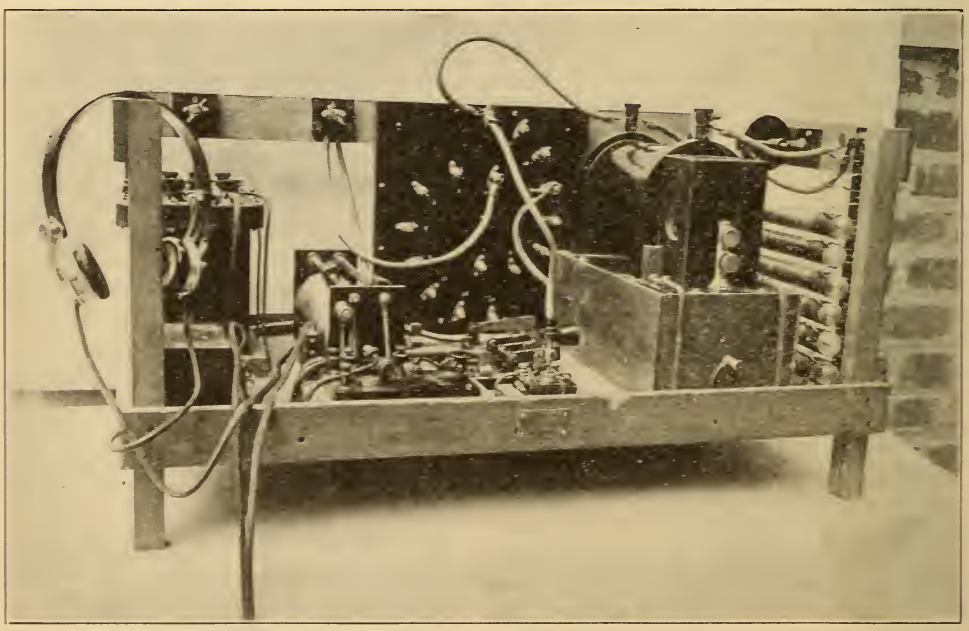
WIRELESS SET FOR AIRSHIPS

BY WALDON FAWCETT

The officers of the Signal Corps of the United States Army are pluming themselves on an achievement which gives evidence that in one important branch of preparedness for war they are in advance of the military authorities of all other nations. This latest proof of Yankee progressiveness in discovering new means of military communication is found in the invention of a wireless telegraph set for use with aerial craft of various kinds and particularly with dirigible balloons which bid fair to play an important part in the fighting campaigns of the future.

From the moment that it was proven that balloons and other aerial craft would be of practical use in warfare under Twentieth Century conditions it was realized that the value of such adjuncts would be tremendously increased if means could be found for utilizing wireless telegraphy in conjunction with these portable aerial observatories. From the standpoint of the layman there appeared to be few if any obstacles to a combination of the functions of these new factors in warfare, but when electricians and aeronauts took up the question they faced several rather perplexing problems.

In the first place it was essential that the entire wireless equipment to be carried aloft be of minimum weight, for the carrying capacity of the average dirigible or other balloon is limited. Secondly it was considered imperative that the telegraphic apparatus be provided with protectors that would preclude the possibility of a spark from the apparatus igniting the explosive gas which, through accident or design, might escape from the bag of the balloon. Some electricians who have studied the subject contend that with the air currents created



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WIRELESS SET FOR AIRSHIPS

by a balloon traveling at fourteen miles or more per hour and the character of the spark emitted there would be little danger unless a gas leak should, perchance, occur directly above the telegraphic installation, but Uncle Sam's sky pilots have not been willing to take any chances in the matter. Finally, the disposition of the receiving wires and the equivalent of ground wires presented some problems.

When the electrical experts of the United States Signal Corps decided to attempt to

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SHOWING SMALL SIZE OF AIRSHIP APPARATUS

devise a wireless set that would meet these varied requirements the task was given over to Electrical Assistant H. B. De Groot and his helpers in the Signal Corps shops at Washington, D. C. The primary specification was that the entire outfit should not weigh more than seventy-five pounds and this has been met, the actual weight of the recently completed set being within the limit by a margin of nearly five pounds. In the experimental set just perfected the Signal Corps electricians have also been successful in completely covering the spark gap so as to exclude gas, and in similarly protecting the interrupter contact.

This pioneer balloon wireless set occupies a novel frame, specially constructed of selected white pine and which is 15 inches high, 17 inches wide and 30 inches long. When in service this platform carrying the telegraphic equipment will rest across the keel or skeleton framework of the dirigible balloon, supported upon the two upper horizontal rods of the keel. If need be the entire outfit can be covered with a tarpaulin as a protection from the weather.

The battery is an ordinary eight-volt sparking battery such as is used in automobiles. It weighs only 22 pounds, and what a saving in weight is here accomplished will be the better appreciated when it is explained that the regular standard battery of the same voltage which forms a part of the regulation "field wireless set" of the Signal Corps weighs 50 pounds. Of course this economy of more than 100 per cent in weight entails some sacrifice of the life of the battery, the aerial equipment having 40 ampere hours' capacity as against 60 ampere hours' capacity in the case of the field set.

The aerial of this new outfit is a special construction and thoroughly unique. It consists of three wires, each 150 feet in length, suspended from a cross arm attached beneath the keel or car of the balloon so that instead of the sound waves being caught above the station, as in all earthly installations, they will be caught below the station. In lieu of a ground wire the wire network which holds together the keel or framework of the dirigible balloon is to be used. If it be desired to use this new set in connection with a spherical balloon carrying a basket it will be necessary to wrap around the basket some wire netting or other similar medium to serve as a "ground."

The features of the equipment just described are especially significant because, aside from proof of elimination of the danger of explosions, the main points to be demonstrated by the forthcoming tests of this new wireless set will concern the success of working two aerials—that is the practicability of working between two capacities at high altitudes. The Signal Corps experts themselves have no misgivings on this latter score because for some time past they have been using practically the same expedient in their field work, with entire success. In the field work there is regularly employed an aerial 60 feet above ground and a counterpoise six feet above the ground and the results have been more satisfactory than when the earth itself was utilized.

The protective appliances of the new set are also of interest as absolute novelties. The cover provided for the interrupter contact is a wooden case with felt gaskets at the joints or wherever it comes in contact

with the surrounding fittings. There is a small opening in one side of the case, with mica window, which gives the operator a view of the contact and enables him to adjust it without opening the case. The spark gap is enclosed in a glass cylinder with hard rubber ends. The glass is removable when it is necessary to make repairs. The only place where a spark may occur which, under the present construction of the set, is left unguarded, is at the key contact. This is considered in no sense a danger point as the spark is almost entirely eliminated, but ultimately it may be decided to make assurance doubly sure by placing a hood over the key.

HOW TO MAKE A POTENTIOMETER.

BY PAUL N. HAIGH.

A potentiometer and a rheostat accomplish the same results but by different means. The potentiometer changes the applied potential or voltage while the rheostat reduces the current by adding resistance to the circuit. The potentiometer is used widely in wireless in connection with an electrolytic detector or other detector employing a local battery, it being so delicate that a very fine adjustment of current can be obtained. A potentiometer suitable for wireless purposes may be constructed as follows:

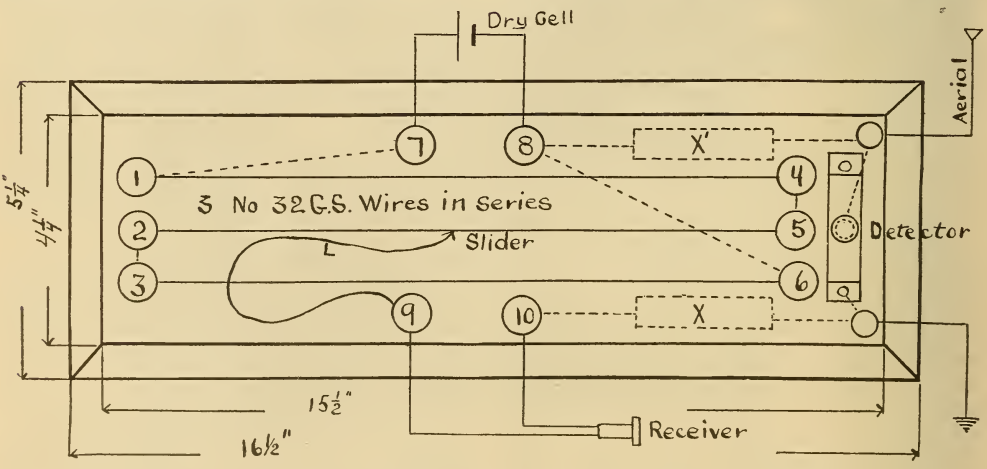
Obtain a base of any suitable wood about 16½ by 5½ inches over all, with a one-inch bevel which greatly improves its appearance. It will also be necessary to obtain ten large binding posts of any form.

Three of these binding posts should be fastened close to one end exactly one inch apart. In line with these and at a distance of 12 inches fasten three more similar to the first three. After this has been done connect posts (4) and (5) and (2) and (3) together with a piece of copper wire sunk in the under side of the base as shown in the diagram.

Three pieces of 32 or 34 B. & S. gauge bare German silver wire must be fastened between the six binding posts and drawn very tightly.

Two of the remaining binding posts (9) and (10) should be placed at a point half way between the two sets of posts at each end. One of these is connected beneath the base through the choking coil (x) to the detector, while the other is joined to the flexible lead (L) by which contact can be made at any point on the three resistance wires.

Two binding posts (7) and (8) should be placed opposite (9) and (10). These must be connected as shown, (7) joined to (1), and (8) to (6); (8) is also connected through the choking coil (X′) to the detector.



CONSTRUCTION OF A POTENTIOMETER

The two choking coils (X) and (X′) are made by winding three layers of No. 22 or 24 B. & S. single silk covered copper wire upon a piece of iron wire three inches long and one-eighth inch in diameter. These should be mounted in small groves on the under side of the base. The detector may be mounted upon the same base.

In order to operate the potentiometer it is only necessary to move the slider along the wire until the signals are the clearest.

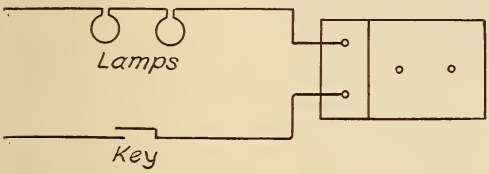
WIRELESS QUERIES

ANSWERED BY V. H. LAUGHTER

Receiving and Sending Radius.

Questions.—(A) What will be the receiving radius of my wireless which is of the following equipment: Aerial center 44 feet in height, made of four No. 14 copper wires strung one foot apart and thirty feet long; auto-coherer and electrolytic detectors; tuning coil and potentiometer, and a pair of 1,000 ohm telephone receivers; also a variable condenser? (B) What will be the sending radius with same aerial, two-inch spark coil, variable condenser, zinc spark gap and inductance? (C) I wish to run my induction coil by direct current from the electric light mains. How can I do this? (D) Will a slight continuous vibration of the table on which the complete set rests affect its efficiency?—L. S., Delta, Colo.

Answers.—(A) From 100 to 500 miles. You have got an ideal equipment for experimental work.



LAMPS IN SERIES

(B) From 5 to 15 miles.

(C) Insert 16 c. p. lamps in series with primary terminals of coil and light mains and key as shown in the diagram.

(D) The table on which the instruments are placed should be free from vibration. The vibration would have no effect on the sending efficiency, but the receiving instruments would be constantly out of adjustment and you would no doubt have considerable trouble in this respect.

Leyden Jars.

Questions.—(A) Would a square jar, with round corners, and a thickness of $\frac{1}{8}$ inch, do for a Leyden jar? (B) How could I run a 2-inch coil on 220 volts? (C) How long a spark could I get from a coil with a nine-inch primary, wound with two layers of No. 16 magnet wire and a secondary of five pounds of No. 32 wire, wound in sections?—K. W. W., Fort Scott, Kans.

Answers.—(A) Yes.

(B) See answer to L. S., only use three lamps in series.

(C) Possibly two or three inches. By referring to the article, now running, on sparks coils you can find valuable directions on the exact method of constructing various sizes of spark coils.

Potentiometer and Aerial Elevation.

Questions.—(A) Will you explain the potentiometer as used in wireless work? (B) For experimental purposes in using a kite aerial for wireless work does it make any difference in the efficiency if the wire connecting the kite to the detector is large or small? (C) What is an inductance coil?—J. C., Troy, Kans.

Answers.—(A) A potentiometer is simply a regulating rheostat used to control the battery current that operates the detector. See article in this issue by Mr. Haigh on "How to Make a Potentiometer."

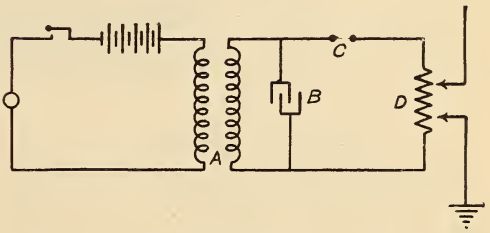
(B) The larger the wire, the more surface offered and the receiving efficiency would be slightly increased.

(C) An inductance coil is simply wire wound in the form of a coil. When placed in an alternating current circuit, it presents an impedance to the flow of the current owing to the inductive effect of the neighboring turns upon each other which creates a sort of "back pressure" which counteracts the impressed voltage.

Condenser; Coherer.

Questions.—(A) How is a condenser connected in series with the spark coil for wireless use? (B) Could a dynamo of 500 watts be used and connected with a two-mile wireless set? (C) How could a magnet be made for working in connection with a coherer?—E. J. B., San Francisco, Cal.

Answers.—(A) Diagram of the complete circuit is given herewith, in which (A) represents the induction coil or transformer, (B) the condenser, (C) the spark gap and (D) the helix.



SPARK GAP BRIDGED BY CONDENSER

(B) It would only be of use to supply current to the coil.

(C) We fail to get the exact meaning of your question. A de-coherer, if this is what you have in mind, is shown in Fig. 2, in the answer to H. H. L., Tacoma, Washington, in the June issue.

Tuning Coil and Potentiometer.

Questions.—(A) Can I wind my tuning coil so as to have the turns a distance apart, or can I wind them close together? (B) Please give me a description of a good contact for the above coil? (C) Which is the best, zinc or brass spark gap? (D) What is a potentiometer used for?—E. L. D., New Castle, Pa.

Answers.—(A) The turns can be wound close together if there is enamel on the wire to provide insulation.

(B) A very good contact can be made by bending a brass spring to an inverted "V" shape, and mounting the spring on a brass rod in such a manner that it will slide up and down. The enamel is now scraped off the wire in a width of one-fourth inch all the way down the frame. The brass rod is now screwed on the frame so that the sliding contact will make connection with the turns when run up and down.

(C) For general use, zinc is conceded to be the best.

(D) To regulate the battery current which flows through the detector.

Condenser Plate Connections.

Question.—In the article on "Spark Coil Construction and Operation" it says that thin brass strips are folded over the exposed portion of the foil strip. Are all the foil strips treated in this way? Or, if not, how are the connections between the plates made?—J. A. D., Winnipeg, Man.

Answer.—As explained in the article the foil strips protrude one inch out from the edge of the bond paper. This will allow all the alternate strips to be connected together. Each condenser or bank should be built up and the brass strip folded over and screwed down as explained. It is only necessary to use the brass strips on each bank.

Hot Wire Ammeter.

Questions.—(A) What good is a hot wire ammeter in a wireless telegraph transmitter? (B) Please give dimensions and diagram for a transmitting helix and size and kind of wire used. (C) Why is it that when you put a 50 or 75 candle-power lamp in series with the 110 lighting current you get more current than with a 16 or smaller candle-power lamp? (D) Does more than one tuning coil help in receiving messages?—S. B., Seattle, Wash.

Answers.—(A) The hot wire ammeter is used to indicate when the set is radiating the maximum amount of energy. By connecting the hot wire ammeter in series with the aerial and pressing the key of the sending circuit an oscillating current is sent surging up the aerial which heats the thin wire of the meter, thereby causing it to expand and move the indicating needle. It is evident that increasing or decreasing the current surging through the aerial will cause a like change of the indicating needle.

(B) We refer you to answers in the May issue.

(C) The larger lamp has a more conductive filament and will allow more current to flow through.

(D) No.

Detector.

Questions.—(A) Must both contacts in an electrolytic detector be platinum or may one be brass, copper, etc., and the other platinum? (B) What size platinum wire should be used? (C) Would the insulation of my coil be the same if immersed in linseed oil instead of boiling out in paraffine?—E. F., Chicago, Ill.

Answers.—(A) Both contacts are usually of platinum, although other contacts are sometimes used. The contact or point, which is connected to the aerial, should always be a fine platinum or Wollaston wire. The objections to using other two kinds of metals is that the acid will soon eat the contact away, owing to the electrolytic action.

(B) Wire .004 inch in diameter is usually employed.

(D) Yes. The spark coil you describe in your letter will give a two and one-half to three-inch spark.

Interrupter Trouble.

Question.—I have been trying the electrolytic interrupter, made per directions in the December issue, but am troubled by the platinum tip heating to redness and then when the current is shut off, the glass cracks and lets the mercury drop to the bottom of the vessel. Current used is 110 volt d. c. about five amperes. How can such an interrupter be made to use on this current wich will avoid the difficulties encountered?—H. J. H., Mattoon, Ill.

Answer.—The trouble you refer to is a very common occurrence with a home-made electrolytic interrupter. In spite of the apparent simplicity the electrolytic interrupter is hard to construct, that is, for efficiency and results. For the usual type the heating effects are avoided by placing a coiled tube in the jar and circulating water through the tube. A second point for trouble might be in the platinum point. In case the platinum point is too small, the heating effects are great. We would suggest that you make several points and use the one which gives the best results.

ELECTRICAL MEN OF THE TIMES

OTTO M. RAU

There is a particular type of man indispensable to the installation and operation of the electrical equipment of any large railway or light plant; a man who not only is thoroughly conversant with electrical and mechanical theory but who is also of a practical turn of mind, resourceful and ready with a cure for every ill to which the equipment is subject; full of ideas, which result in economies here and there in the intricate system which he has at all times within his perspective. Such a type of man is Otto Martin Rau, who holds the responsible position of chief electrician of the Milwaukee (Wis.) Electric Railway and Light Company. To use an expression so common in these days, he is a man "who can do things."

Mr. Rau is not a college graduate, but he knows the theoretical side of electricity and mechanics just the same. He supplemented his public school education by a laboratory course with the Daft Electric Light Company, graduating from the engineering department of that concern well founded in the principles of the work he was to undertake. During 1887 to 1889 he did some experimental work on the third-rail electric traction system of the New York elevated railway. After that he helped put in electric railway systems for St. Clair, Pittsburg, Los Angeles and other cities, all the time gaining more knowledge of electric railroading, which he realized was going to become one of the most important branches of the whole electrical industry.

But electric railways and lighting interests are often associated, so he prepared himself in the latter branch by joining the forces of the Edison General Electric Company, as it was then called, as designing engineer in the lighting department, working on searchlights, arc light dynamos and lamps and distributing systems. Here he laid out the electrical distribution systems of Cincinnati and Milwaukee, becoming resident engineer on the latter work until it was completed. He then accepted the position of chief electrician of the Milwaukee company, in which capacity all construction work in the electrical department is under his supervision, the more important work having been the construction of the electrical equipment for the Oneida Street power plant, the Commerce Street power plant, including the underground distributing system at 13,200 volts and substations, and the electrical work in connection with the Public Service Building of the company.

Outside of his work in connection with the Milwaukee system, Mr. Rau finds time to act as consulting engineer, and the most notable of his achievements along this line have been the supervision of the electrical installation of a hydro-electric plant for the Wisconsin Traction, Light, Heat and Power Company, and of the power plant and substations for the Union Electric Light and Power Company of St. Louis, both important engineering undertakings. He is now engaged on the installation work connected with a tower transmission line which will bring current at 66,000 volts pressure from the new power plant at the famous Dells of the Wisconsin River to Milwaukee, a distance of over 100 miles.

Mr. Rau is a member of the American Institute of Electrical Enginers and of the Northwestern Electrical Association.

ELECTRICITY IN THE HOUSEHOLD

SOMETHING NEW IN DECORATIONS

When it comes to decorative lighting fixtures electricity is far and away the most adaptable form of illumination. It not only lends itself readily to all forms of electroliers where gas could be used, but in addition opens up a new field for those of artistic bent who would design creations of a more elaborate sort embodying floral designs and the like. To give an idea to the hostess who wishes to have her decorations "a little different" from those commonly used, a few photographs are reproduced herewith, showing some very unique designs which have been worked out for the utilization of miniature electric lamps in a variety of pleasing ways.

View No. 1 represents a small electric fountain set in a basket of artificial plants and flowers. The flowers are represented by small electric bulbs all connected to one circuit. By screwing the attachment plug into the lamp socket and turning on the current the fountain commences to play immediately and the lamps light up. View

ELECTRIC FOUNTAIN CENTER PIECE

No. 2 represents a similar fern effect, the fountain being replaced by a water effect representing a pretty fern dell. Another similar design is shown in view No. 3.

Some new metal designs are illustrated in Nos. 4 and 5. One is an oak ceiling fixture with acorn shaped bulbs, another represents a cala lily and the third a double branch poppy. These last designs are made in copper with verdigris or other finish and are supplied by the maker in a form suitable for wall brackets if desired. A wide range of floral designs are also available, outside of the ones illustrated.

ELECTRIC LIGHT AND HEALTH.

BY NOBLE M. EBERHART, M. D.

With the greatly increased use of the electric light in the homes and offices, comes the thought of its possible effect on the health of the community and a comparison between the electric light and gas in this respect. That the incandescent light is immeasureably superior to gas when thus compared, there can be but little doubt.

White light embraces all of the colors making up the spectrum, from the red, which represents the lowest number of vibrations, up to the violet, which is produced by the highest number which the human eye perceives as light or color. The red rays have been shown to influence the body principally through the effects of the heat produced, but the violet rays possess chemical properties and cause changes to take place in the skin and tissues. With them, skin diseases, and even malignant growths have been cured. From a cosmetic standpoint, the complexion of individuals exposed to these rays is greatly improved, and since the higher the candle power, the more of the beneficial rays given off, the superiority of the incandescent light is evident.

Another point of even greater importance is that gas consumes great quantities of the oxygen in the air, and thereby lessens the value of the air to the occupants of a room. This has long been recognized by surgeons who object to the administration of chloroform in a gas-lit room because of this great destruction of oxygen and the increased danger to the patient.

The value of oxygen is too well known at the present time to cause anyone to un-

ELECTRICAL DECORATIVE DESIGNS

necessarily sacrifice any of this life-giving element, so that electricity not only furnishes a light that is more brilliant and more convenient than gas, but one that is of far greater benefit to the health of the community.

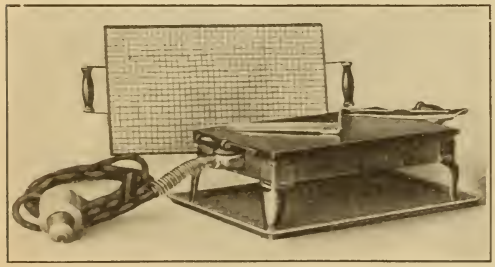
There is another menace to life and health in the use of gas which does not enter into the use of the electric light. This is the effect of its inhalation; or gas-poisoning. This may result from several different causes, such as small leaks from defective connections; intentional inhalation with suicidal intent; accidental blowing out of the gas, and finally, its going out when turned low, from variation in pressure.

Intentional or accidental destruction of life is impossible with the electric light, but scarcely a day passes that we do not read of a case of asphyxiation by gas. Death by this means is so easy and painless that it seems to be a constant temptation to those with suicidal intent. This is certainly an important and vital reason for preferring the electric light.

The effects upon the system of the respiration of small quantities of gas are not so easily estimated, but that they must materially interfere with various bodily functions and gradually undermine the resistance of the system to other diseases or poisons will be readily inferred.

BREAKFAST-GETTING SIMPLIFIED.

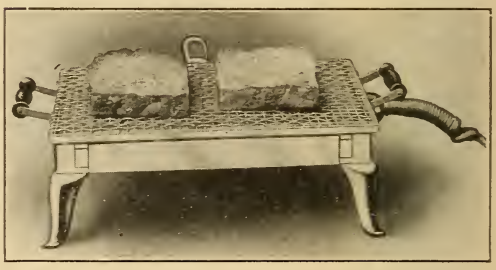
It has been said that positively the last word in the construction of a combination cooking appliance for table use is embodied



ELECTRIC STOVE AND TOASTING GRID

in the electric toaster and stove here shown. However that may be, it is certain that the device has many features which make it appreciated in any household, where it will find innumerable uses. It may be employed in any part of the house where there is a lamp socket, and its manifold accomplishments are available at the turn of a switch.

In the first place there is the little flat-top stove measuring seven by eleven inches, and weighing five pounds. This has an electric heating element underneath the top and is



TOASTING GRID IN USE

set in operation by simply "plugging in" from the nearest lamp socket with the cord attachment which is furnished. It is available for any voltage from 100 to 125, and the voltage of the regular lighting current will come somewhere between these two limits. In addition there is the toasting grid, consisting of a wire screen with suitable handles, which fits on the top of the stove. This insures an even heat on all parts of the slice and insures delicious, evenly browned toast. There is also a broad, shallow tray which may be used to hold the stove on the breakfast table, or as a crumb tray. If desired the stove top may be inverted, turning up a narrow rim which serves to retain fluids on the hot plate.

THE STORY OF THE ELECTRIC FAN.

The electric fan was an American invention which has been developed within the last few years until millions of the fans are in use throughout the world. Back in the early eighties Dr. S. S. Wheeler, an electrical engineer of New York, was experimenting with a small electric motor. In the course of his experiments the doctor conceived the idea that steamboats might be run with electricity if the propellers could be direct connected to high-speed electric motors, doing away with all the gears then in use in steam propulsion. With this idea in mind he had a small screw-propeller constructed and fastened it to the armature shaft of his small motor. To his surprise the experiment resulted in a fine breeze of cooling air which more than delighted the

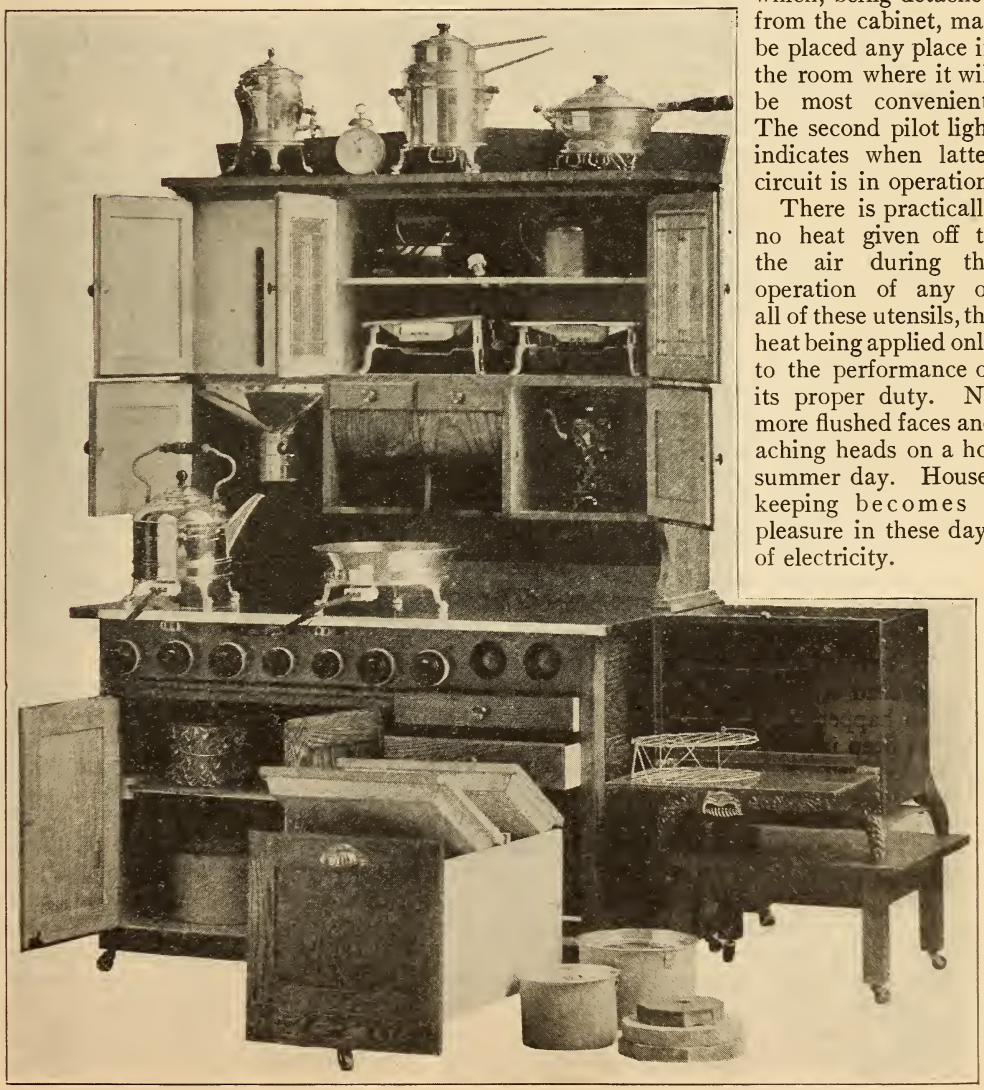
experimenter, for the day was decidedly hot. It is needless to add that the experiments with screw-propellers ended right there and the engineer took up the study of the electric fan with the result that he soon perfected the device until it was a commercial success.

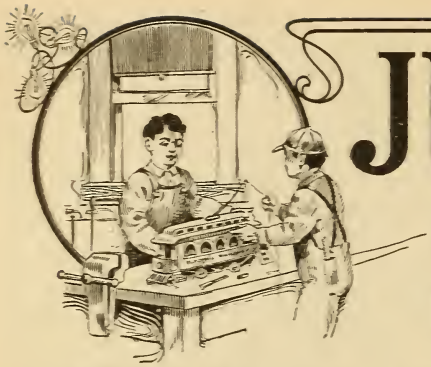
THE FIRELESS COOKER.

A place for everything and everything in its place is a saying which was perhaps never better applied than to the fireless cooker cabinet shown in the picture. A description of this marvelous piece of kitchen furniture (it might be termed a whole kitchen in itself) is hardly necessary, for any woman can appreciate its convenience at a glance. A few pointers concerning its electrical equipment may not be out of place, however.

To begin with, all the wiring is concealed within the cabinet, only the switches being visible and the little flexible cords and plugs which are connected underneath the edge of the shelf and lead to the various electric cooking utensils. The oven at the right is also electrically heated. The first six switches are used for the cooking devices seen on the top of the cabinet and the first pilot light at the right of the switches shows when the current is properly turned on and working. The last switch is for the oven, which, being detached from the cabinet, may be placed any place in the room where it will be most convenient. The second pilot light indicates when latter circuit is in operation.

There is practically no heat given off to the air during the operation of any or all of these utensils, the heat being applied only to the performance of its proper duty. No more flushed faces and aching heads on a hot summer day. Housekeeping becomes a pleasure in these days of electricity.





JUNIOR SECTION

STORY OF THE VILLAGE LIGHTING PLANT

BY REX UNDERHILL

Those who travel across the Empire State by night and chance to look out of the car window while passing a certain rural village of about a thousand souls will be astonished to see the place ablaze with electric lights. The fact that so small a village, located so far from any city or large town, is nightly illuminated with electricity, including the few streets, the stores and shops and nearly every one of the country homes, is a continual source of surprise and wonder to the traveler.

Now this is the story of how that particular village obtained its electric lights.

A certain young man there was who became very much interested in electricity, although he worked every day in one of the stores in this village. This was several years ago and the young man had just graduated from the village High School where the small laboratory had given him his first ideas of electrical machinery. He read and studied everything he could find on the subject of electricity whenever he could find the time to read books.

It so happened that about the time that he was deep in the subject of electric lighting plants for small cities and villages he became of age and a small sum of money left him by a thoughtful grandparent, was placed at his disposal. This, added to what he had saved since he began selling papers and working at odd jobs, gave him almost $4,000, quite a sum of money for a young man of twenty-one in so small a community.

With this money placed to his credit in the bank the young man went straight to three of the best known and wealthiest men of the village and unfolded the scheme which had been framing itself in his mind for years. It was nothing more or less than a plan to establish an electric light plant for the village.

Of course these old men, who walked nightly home in the dark when the oil lights were not lighted or followed the tiny beacons when they were, pooh-poohed the idea from the start.

"Why, such a plant would not pay," they echoed. "If we had a fine water power maybe we could do it but with coal—why, it is ridiculous, preposterous."

Then the young man collected and brought to them whole pages of facts and figures and carefully explained every detail of his experiment. "Now I am willing to risk four thousand dollars, all I have in the world, in this venture, for I believe it will be a success," said he. "If you doubt these figures let me send for an engineer from one of the big electric companies, it will cost us nothing, and he will verify all that I have shown you."

One of the merchants snorted something about "a fool and his money" and left the room. The two others, more to favor the young man than anything else, because they had long known his family, consented to talk with the engineer.

In a few days the engineer came and made a thorough inspection of the village. He found out that coal could be had for about $3.50 a ton; he went over the young man's figures and pronounced them correct except in one or two places, where he had actually been too high; he interviewed the President of the village and the members of the Board and got their consent for street lighting;

talked with the merchants and the householders, then pronounced the venture a good one and advised the men to go in with the boy and build the plant.

After due consideration and investigation they agreed to form a company, place one of the men in as president, the young man as business manager, and turn the sum of $10,000 over to him with which to build and establish a local electric lighting plant.

The young man in question resigned his position in the store and started the work. It was no easy task, for the details of the construction work were even larger, and harder, than he had anticipated, but he met and conquered them all.

HE BROUGHT THEM WHOLE PAGES OF FACTS AND FIGURES

The powerhouse was soon built, a small, neat brick building close to the railroad yard where carloads of coal could be switched in for the coal bunkers. The chimney was the most conspicuous tower in the whole village. By the time the building was ready the machinery was at hand and engineers and construction men from the various manufacturing companies took up the task of setting up the generator and connecting it with the engine.

The engine room of the small power plant contained, when all was finished, one alternating current, 80 horse-power generator connected by a wide belt to a 125 horse-power steam engine. The boiler was of 135 horse-power capacity. The little engine room was spick and span with polished brass, bright paint and shiny varnish.

The village authorities gave the lighting company a franchise to set up the transmission poles along the streets and contracted to have the village lighted with arc lamps. It took some time to string the wires, to get all the instruments and devices for the control of the current, and the protection of the apparatus, in place and ready for work. Then the linemen and electricians began the work of hanging and connecting the 30 enclosed arc lamps of 1,200 candle-power capacity which were to light the streets.

Even before the powerhouse was finished the merchants and a few of the house-owners began to send for electricians to come and wire their places of business and their homes.

Then one dark night when all was ready the young engineer threw the switch and the streets seemed to fairly burst into light—such was the contrast over the old oil lamps. Another switch and the village hotel was beautifully illuminated and two of the largest stores. The president of the lighting company was also ready for the occasion and lighted every room in his house so all could see the beauties of electric lighting in the home.

The contrast between electric lights and the oil kerosene lamps for store and house lighting was so great that nearly everyone, except a few who were afraid of electricity because they feared lightning, placed an order to have their store, shop or home wired.

In less than a year's time the little lighting plant was supplying current for thirty-four enclosed arc lamps used in the stores and shops and over a thousand incandescent lamps in the homes. The village itself contracted for thirty arcs and twenty incandescent lamps at a cost of $55 a year each for the arcs and $15 a year each for the in-

candescent lamps. The houses were all placed on a fifteen cents a kilowatt hour rate.

By judicious buying the young man in charge of the plant worked the fuel cost down to $3.30 a ton and as the plant stopped at midnight each night and did not run during the day the cost for maintenance was very low. He was very studious and careful and kept the plant in such excellent shape that the bills for repairs came seldom and never amounted to very much. In this way the plant began straightway to pay a handsome profit on the investment. Thus the young man secured a fine job at the profession he was devoted to, and his money was invested so as to bring him large returns yearly. The man who made the remark about the "fool and his money" and refused to invest in the concern in the beginning afterwards tried to buy some of the stock, offering a large premium.

PERILS OF THE LINEMAN.

Often persons do not give any thought to the dangers to which linemen of the telegraph, telephone, electrical power and light companies are subjected. The average person does not care. He does not bother his head about the men who, in all sorts of weather, climb the poles and buildings for the purpose of restoring order in the lines after a hurricane.

So long as the winds do not blow severely, or the snows fall heavily or other elements combine to overthrow or overweight the lines and poles, there is not much for the lineman to do outside his regular line of repair work. There is a certain amount of new construction work in progress most of the time, but the work can be done slowly and quietly. But when a storm suddenly comes up the linemen are the first ones to feel the effects. The very first winds take down the weakened poles and wires and from then on until the termination of the storm, it is one series of crashes, breaks, hurry-up calls, trouble, wreckage and hardships. The men have no more rest until the last echoes of the storm have passed. Even then there is much to be done. All the work which broke down and was not re-installed while the storm was yet blowing, must be put up. The lines must be kept open. The newspapers want their wires ready for important messages, and the special wires must be attended to—all in addition to the regular service.

A storm or a heavy fall of snow develops the weak points in the line. As soon as the first indications of high winds or heavy rains appear, the lineman proceeds to get ready for business. He knows that it means a hurry-up call very soon. The call is not long in coming. The lineman responds quickly and in a short time he will be at the point where the winds have broken a tree and the tree has fallen across the wires and the tangle and breakage is fearful to look upon. Workmen are secured to cut away and remove the tree, perhaps limb by limb. New wires have to be obtained and pole climbing and wire stringing goes on in earnest. A pole may have been broken off in the fall and then there will be considerable labor required in order to rig up a means to support the wires.

In one instance the pole was partly broken off near the top, but the partial fracture was not observable from the street. The line man climbed to adjust the wires and his added weight snapped the pole off as in Fig. 1, and, owing to a slight curve, it swung

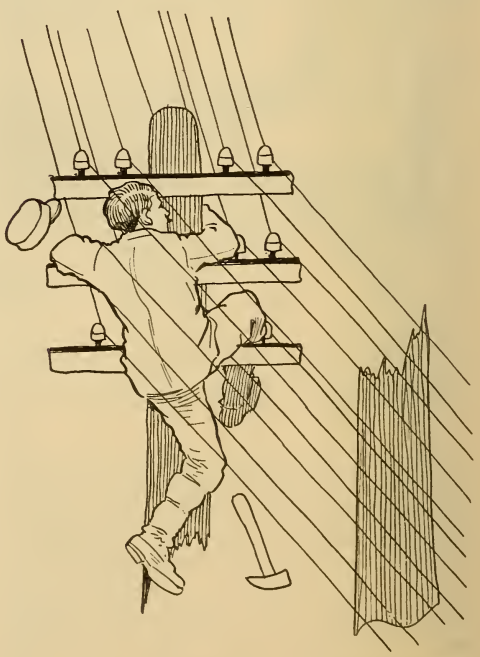


FIG. 1. ONLY THE WIRES TO SUPPORT HIM

out away from the pole. The untrained man would have taken fright and perhaps jumped. That would have meant death or at least a broken bone. Our friend relied upon the wires to support him and in this

instance the wires proved faithful to the cause and supported the top of the pole, the cross arms, and the man, as shown. The combination swung to and fro in the high gale for an hour before ladders were obtained to release the lineman. A fire truck company came out and ran up an aerial ladder directly under the man on the pole, and he descended in this manner.

Of course the companies endeavor to supply their linemen with the most perfect equipments with which to work. But the most careful inspection of working apparatus frequently fails to bring to light certain weak points. These weak points occasionally bring death and disaster to the lineman. Not long since a partly decayed round of a ladder snapped in such a way that the lineman fell outward and backward to the ground, straining his back so that he was laid up for months. In another instance, where a man was

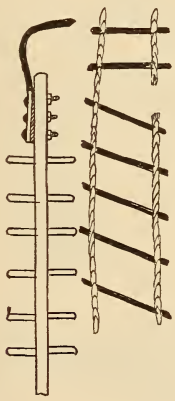


FIG. 2. DANGEROUS APPARATUS

using a ladder hook, of the nature shown in Fig. 2, the wrought iron hook at the top sprung to the extent of slipping off from the ledge of the building over which it had been placed. The lineman making the ascension on this single ladder pole was thrown over backwards with the pole, breaking an ankle.

The companies almost always care for the men who have been hurt in their employ. If the injury is the result of defective devices, lawsuits sometimes follow. Ordinarily, however, the employers and the employees agree and no law suit is filed. The companies pay the wages of the man while he is recovering from a broken leg or arm and also pay the doctor's bill.

Not long since a ladder made out of rope (shown also in Fig. 2) was the cause of an accident to a lineman. It seems that the lineman was ingenious and industrious. One day he contrived a ladder of rope sides and with metal rods extending through loops from side to side. He forgot that metal against hempen rope does not work well.

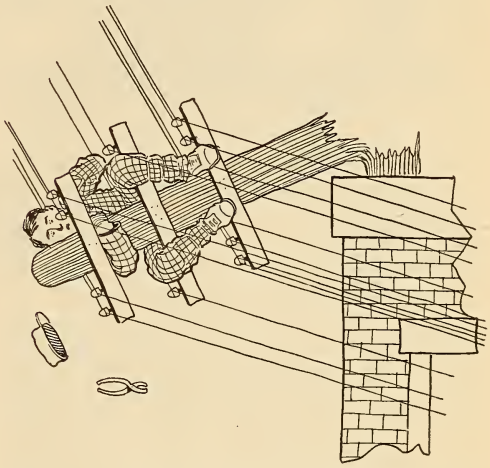


FIG. 3. AN AWKWARD POSITION TO SAY THE LEAST

The metal scored the rope, and thus weakened, one side snapped under strain one day, with the man on it. As this device was con-

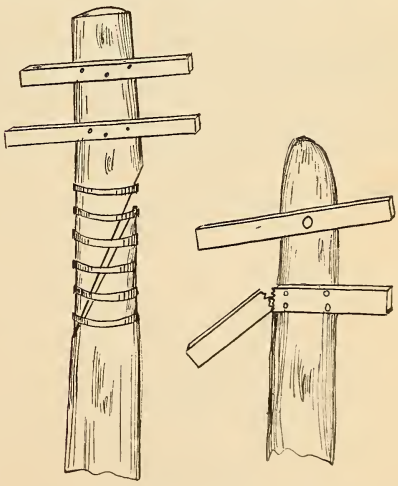


FIG. 4. CROSS ARMS AND SPLICING ARE DECEIVING

structed by the lineman himself, and used for his own convenience, the company could not be blamed for furnishing poor apparatus for its workmen.

Quite a thrilling event happened when a lineman went over the side of a tall building in a strong wind, caused by his weight on a weak pole, the pole breaking off as in Fig. 3.

The top of the pole with its human burden bumped about the cornice of the building for several minutes, with the man clinging thereto, until comrades secured it with ropes and released the man. The lineman has to get used to accidents of this character.

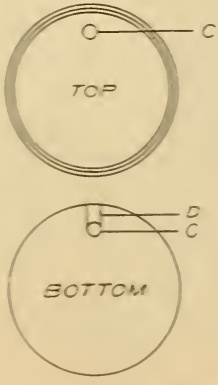
Then there are occasions on which he must be very ingenious and patch poles, so as to keep the line working until the storm is done and a new pole can be put up. Fig. 4 shows one mode of splicing a broken pole with ropes or bands of other material. The pole is adjusted as it was originally and banded, or the uneven fracture is hewn down so that the sides may fit together well.

Cross arms are deceiving as is known, and it is not safe to put too much reliance upon them. Fig. 4 also shows a pole with the top arm bent and the second arm broken. This is a common sight. The wood decays in a few years, and while the coating of paint may make the lumber appear new and strong, beneath the surface all is decay and a pressure may break off the arm and down you may go.

STUDENTS' ELECTRIC LAMP.

BY JESSE FISHER.

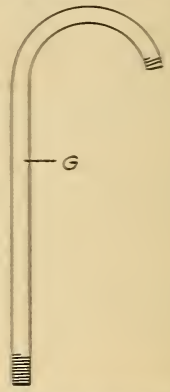
Students' electric lamps for use on electric lighting circuits are not very expensive, but any boy who is of a mechanical turn can easily make one for himself. The one here described will operate either on lighting current or batteries according to the kind of bulb used.



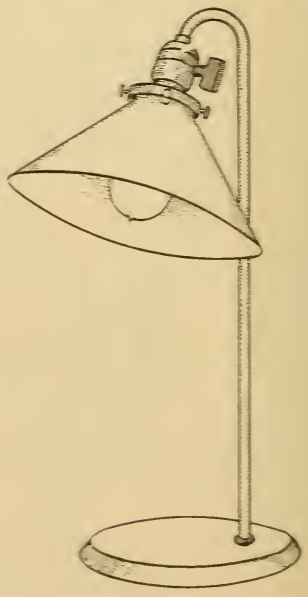
CONSTRUCTION OF BASE

We will first make the base of some hard wood, such as oak or mahogany. It should be about eight inches in diameter and have a $\frac{3}{8}$-inch hole bored in it about two inches from the edge, as shown at (C) in one of the cuts.

A small plate is next made from a piece of strap iron. A $\frac{3}{8}$-inch hole is bored in the center of it and tapped with threads. Holes are drilled through the plate and it is screwed down directly over the $\frac{3}{8}$-inch hole in the base. Then give the base a nice coat of varnish and it is complete.



FIXTURE PIPE STANDARD



LAMP COMPLETE

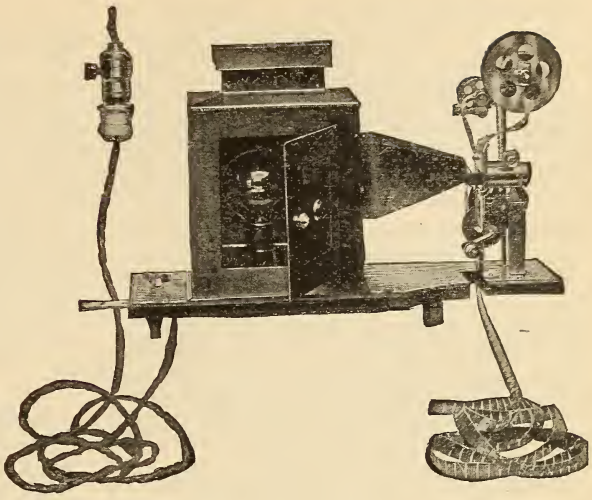
Next secure a piece of fixture pipe about two and one-half or three feet long and care-

fully bend as shown. Thread about one inch of the lower end (to fit the plate on the base) and about ⅜ inch at the other.

Insert two fixture wires in the pipe, being sure the insulation is good. Attach an Edison key socket to the wires and screw in place at the end of the bend. Then tighten the wires and screw the pipe in place on the base. A flexible cord should be attached to the ends of the wires underneath the base and passed out through the groove (D). The wires at the joint should be separately wrapped with tape, to insure perfect insulation.

Any style of shade may be used, but the tin cone fills the purpose very well.

If you are going to use it with electric lighting circuit use a regular 16 c. p. bulb. If you wish to operate with battery, use a 14-volt miniature lamp, with seven or eight cells of battery in series.

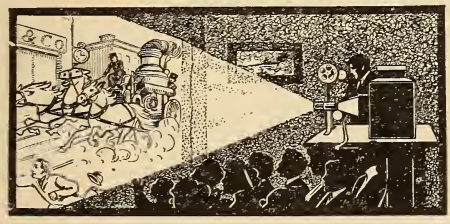


THE IKONOGRAPH

The electric lamp, which is of 100 candle power, burns from the regular lighting circuit and is connected by means of a cord and plug.

MOVING PICTURES IN THE HOME.

The old-fashioned magic lantern has enlivened many a long evening, but the boy of today wants something better than that, so real moving picture machines are now made in sizes suitable for use in the home. With the Ikonograph, one of the new machines, any boy can furnish an entertainment which is worth going some distance to see.

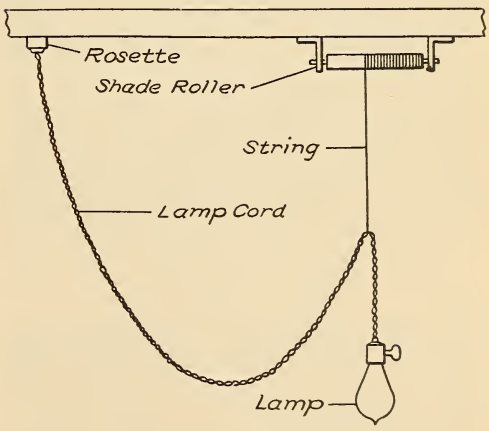


MOVING PICTURES IN THE HOME

The Ikonograph throws real moving pictures 2½ to 7 feet high and 4 to 11 feet wide. There is no danger of fire or explosion as a powerful incandescent lamp is used instead of an arc light. Everything is complete, including an automatic film feeding device, automatic shutter, film rewinder and a screw focus for the projecting lens. A special ray reflector throws a sharp clear picture.

ADJUSTABLE LAMP FIXTURE

The boy who is fortunate enough to have his own workshop or laboratory will find an adjustable fixture very convenient for raising and lowering a drop light. It is made by fastening a window shade roller to the ceiling and fastening a string to the roller. The other end of the string can be fastened to the lamp cord somewhat as shown in the illustration. The lamp can then be adjusted in the same way as a window shade is ordinarily adjusted.



ADJUSTABLE LAMP FIXTURE

QUESTIONS AND ANSWERS

Readers of Popular Electricity are invited to make free use of this department. Knowledge on any subject is gained by asking questions, and nearly every one has some question he would like to ask concerning electricity. These questions and answers will be of interest and benefit to many besides the one directly concerned. No consideration will be given to communications that do not contain the full name and address of the writer.

Resistance of Copper Wires; Alternating Current Motor Operation.

Questions.—(A) How can the resistance of different sizes of copper wire be figured? (B) In the windings of a three-phase stator how does the current flow and return, as we have only three leads? (C) Is induced current in the rotor of a motor of the same potential as that in the armature coils? (D) Are the phases represented in the rotor? (E) Explain flow of current in delta connections.—L. D., Cincinnati, Ohio.

Answers.—(A) The resistance of a circular mil foot of copper is 10.5 ohms at 75° F. The resistance of a wire decreases as its cross section increases, hence the resistance in ohms of a wire of any length is the resistance of one mil foot of the wire, multiplied by its length in feet, and divided by its cross section in circular mils. To illustrate further, a wire one quarter inch thick has a diameter of 250 mils. The cross sectional area equals 250x250=62,500 circular mils; that is, the square of the diameter in mils (1-1000 inch) equals the area in circular mils. A copper wire 5,000 feet long and 49,000 circular mils in cross section has a resistance of (10.5x5000)=49,000—1.07 ohms.

(B) In a balanced three phase system the currents in the three leads are 120 degrees apart. At all times the sum and direction of the three currents equals zero. When the current in one phase is at its maximum, the sum of the other two currents is negative; that is, either one or two of the three wires are acting as return circuits.

(C) We assume that you mean stator when you say armature coils. When an induction motor is at a standstill the relative speed of rotor and stator is S. and the E. M. F. is the same in both. When the rotor runs at a speed s, the relative speed of the rotor and stator drops to S—s, and the E. M. F. drops in the same proportion in rotor conductors as $\frac{S-s,}{S}$ or if $Q=\frac{S-s,}{S}$ the E. M. F. in the rotor becomes at speed s, Q x E.

(D) The instantaneous values of corresponding stator and rotor conductors are equal to each other, and are opposite to each other in phase.

(E) See answer (D).

Figuring Size of Wire; Protection of Circuits.

Questions.—(A) What should be the voltage of a dynamo to light 20 lamps of 110 volts and 16 candle power? I want to light six lights one and one-half miles from the dynamo, and the other 14 at and near the machines. (B) What fuse protection do I need?—H. C., Sedalia, Mo.

Answers.—(A) Three per cent increase in voltage halves the life of a lamp, while six per cent increase reduces the life by two-thirds. For the above reason to obtain satisfactory operation of the lamps at the machine, the dynamo should operate at practically 110 volts. The drop in voltage allowed on transmission lines is all the way from five to 15 per cent. In this case, considering the lamps at the far end, and providing for a drop of only one per cent, the following formula may be used to figure the size of conductor needed:

$$C\ M=\frac{10.8 \times L \times C}{V}$$

Where V=drop in voltage; L=length of wire in feet; C=current sent over wire; C M=cross section in circular mils. From which

$$C\ M=\frac{10.8 \times 7920 \times 3}{1.1}=16,510$$

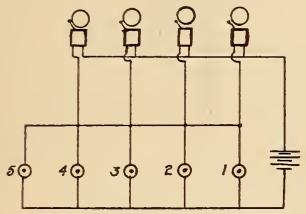
No. 8 wire fulfils the condition.

(B) Leads from the generator should each be provided with a fuse so that in case of a short circuit beyond the fuses these will blow out before current in excess of the generator's rating is sent out.

The National Electric Code requires "that no set of incandescent lamps requiring more than 660 watts be dependent upon one set of cut-outs. The fuses in the branch cut-outs should not have a rated capacity greater than six amperes on 110 volt systems."

Special Bell Circuit.

Question.—Will you please show me how button No. 5 should be connected to ring all four bells at once.—H. A. E., New York.



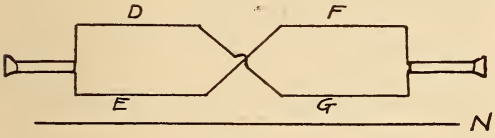
SPECIAL BELL CIRCUIT

Answer.—Connect wire from bell No. 5 as shown in diagram, using about three cells of battery.

Noise on a Telephone Line.

Question.—Will you advise if there is any way to overcome the noise on a telephone line, caused by induction from a high voltage transmission line? —C. C. B., Norfolk, Wy.

Answer.—We assume that the telephone circuit is two-wire metallic. Transposition



TRANSPOSITION OF TELEPHONE WIRES

shown in the diagram will destroy the induction effect. If the disturbing wire (N) passes a current in the direction indicated by the arrow, at some given instant, this current will affect the wires (D, E, F, G) as indicated by the arrows, this effect being about the same in each wire, since the average distance of (D) and (E) from (N) is the same. The receivers, therefore, get the result of the impulses in the same direction on wires (F) and (G), and no disturbing sound follows.

Motor Brushes.

Question.—Can a motor run with only one brush? I have two telegraph instruments (sounders), a battery, and a two-brush motor connected in series. When one brush is lifted from the commutator and the battery cut in the circuit, the motor runs at almost the same speed as when the brush is on.—H. J. M., Spokane, Wash.

Answer.—A two-brush motor should not run with one brush lifted off the commutator. This should break the circuit through the armature. As you say it does run, we can see no reason except that the brush holder is so connected that current is in some way conducted to the armature and fields by this holder and thence to the brush still left on the commutator. Does the same thing occur if this first brush is left on and the second lifted?

Induction Fan Motor; Two Phase Formula; Power Factor.

Questions.—(A) What current does the induction motor mentioned in the December, 1908, issue, page 517, take? (B) What is the formula for finding the watts in a two-phase circuit? (C) How is the power factor of use in a rotary station?—R. T., Jenkintown, Pa.

Answers.—(A) That will depend upon the diameter of the fan. If a 12-inch, about one-half an ampere will be required.

(B) Alternators for use with two-phase systems usually have two sets of windings on their armatures, the voltage of one set being at a maximum, when the other is passing through zero. The output of a two-phase machine is the sum of the outputs of the separate phases. That is:

$W=2$ V. A. P

where W=V. A. P is the power formula for a single phase circuit.

(C) The power factor holds for use only on the A. C. side of the rotary. The wattmeter reading divided by the product of the readings of the ammeter and voltmeter on this side of the machine; in other words the real watts divided by the apparent watts, gives the power factor of the A. C. side of the system. and indicates how much the current is lagging behind the pressure or E. M. F.

Magnetizing a Cylinder.

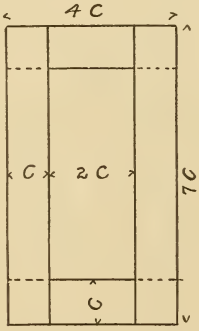
Question.—Is it possible to magnetize the outer surface of a cylinder by having the coil contained inside the cylinder? If so, how?—L. C. T., Elyria, Ohio.

Answer.—By placing a bundle of soft iron wires wound by a coil, inside of the cylinder. The latter would be magnetized by lines of force due to leakage from the coil and also by lines passing out of the north pole and into the south pole. However, the magnetic lines would act very inefficiently, since the maximum number would be within the coil rather than on the outside.

Transformer and Coil Building.

Questions.—(A) In the February, 1909, issue you state how to build a choke coil, but give no definite formula. Are there formulas that may be used? (B) What would be the voltage transformation in the rectifier described on page 692 of the March, 1909, issue? (C) Would it be possible for an amateur with a limited equipment to build such apparatus as voltmeters, ammeters, and wattmeters?—M. L. B., Cleveland, Ohio.

Answers.—(A) Standard authorities are one in the statement that successful designs of transformers and coils are found by the method of cut and try. Manufacturers derive their data from test of new apparatus, and use this in calculating future devices. Each coil, however, has a personality, if we may so term it, of its own.



TRANSFORMER DESIGN

For a transformer, having given the voltages, frequency, and from the voltages the number of turns of primary and secondary, the following formula may be used to determine the cross section of the iron with proportions shown as in drawing:

$$A = \frac{E \times 10}{4.44 \times N \times T \times B}$$

where A=cross section of iron circuit in square inches.
E=primary voltage.
N=frequency.
T=number of primary turns.
and B=lines of force per square inch of the iron cross section.

In small transformers at 60 cycles, a density of 5,000 lines per square inch is deemed best. From the above formula, (A) is readily determined.

(B) For five volts on the A. C. side the D. C. side should give

$$\frac{95}{110} \times 5 \text{ volts} = 4.3 \text{ volts.}$$

For 20 volts the D. C. side should be about 17 volts.

(C) See page 797 of the April, 1909 issue.

A Transformer Example.

Questions.—(A) Please give size of wire, and state what other material should be used in making a simple transformer to step down 220 volts to 50 volts. (B) Referring to "A Simple Transformer" in the November, 1908, issue, please give the size of core and also size of primary and secondary wires to step 100 volts down to ten volts. (C) If 1,000 turns of No. 23 double cotton-covered wire on the primary of a transformer, and 100 turns of No. 13 on the secondary will give 10 volts from a 110-volt circuit, will 1,000 turns of the same (No. 23) to 20 turns of No. 13 give 50 volts?—T. C., St. Joseph, Mo.

Answers.—(A) See answers to M. L. B., this issue; also article referred to in question (B). Wire should be of sufficient size to take off current required.

(B) Answers to your question are given in the article referred to. That is, the transformer referred to has a 10 to 1 transformation and would step 100 volts down to 10.

(C) Yes. The proportional formula for this is:

$$\frac{E_1}{E_2} = \frac{N_1}{N_2}$$

where E_1=primary voltage.
E_2=secondary voltage.
N_1=number of turns in the primary coil.
and N_2—number of turns in the secondary coil.

Dynamo Polarity; Battery Operation.

Questions—(A) How can I determine the positive and negative field poles of a dynamo? (B) Can a storage battery be over-charged? (C) Can a rectifier be made to change 110 volts 60 cycles alternating current to 10 volts direct current? (D) Does the transformer described in the "Junior Section" of the November issue, 1908, change alternating current to direct current?—A. W., San Francisco, Cal.

Answers.—(A) If the north end or pole of a compass needle be brought near the north field pole of the dynamo while running, this end of the needle will be repelled. It will be attracted by the south field pole.

(B) When the active material in the cell is all converted, that is, becomes lead peroxide on the positive plate and spongy lead in the negative plate, continuing to send charging current into the cell produces no effect except to decompose the water, the gases passing off. No harm is done to the plates to continue charging after gassing begins, but the current is wasted.

(C) Yes. Such outfits using mercury in bulbs containing the electrodes are used for charging batteries. An auto-transformer is also a part of the outfit. An attempt to make the apparatus would be, we believe, an expensive proposition.

(D) No. Transformers only step up or step down the voltage of alternating current, the transformation being in proportion to the number of turns the two coils bear to each other.

Changing a Telephone Magneto.

Question.—Can a telephone magneto be changed so it will give direct current without changing armature?—D. W. K., Nevada, Ohio.

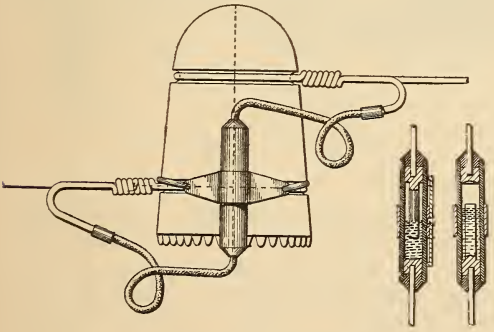
Answer.—Yes, by providing a commutator in place of slip rings on the armature.

NEW ELECTRICAL INVENTIONS

CIRCUIT-BREAKER.

In testing telephone lines and other similar circuits it is frequently necessary to open the wire at some point by cutting it. A simple circuit-breaker to be located at various points along the line in order to do away with cutting the wire has been invented by Lewis C. Steele of Columbus, Ohio.

The cut shows an ordinary double groove insulator with wires attached to the upper and lower grooves. This would ordinarily leave a break in the line, but the flexible wires and circuit-breaker bridge across the gap. The circuit-breaker as shown by the sectional views consists of a tube with two electrodes entering top and bottom. In the bottom of this tube is mercury. When the

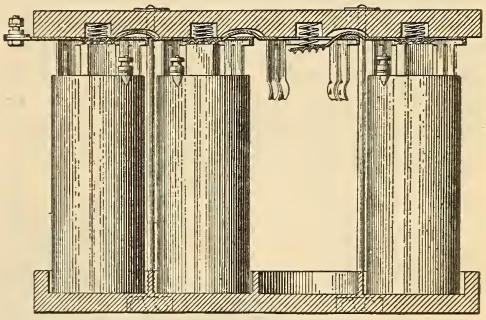


CIRCUIT BREAKER

tube stands upright as shown in the left-hand sectional view, both electrodes make contact with the mercury and the circuit is complete. When it is desired to open the line to test, the tube is inverted as shown by the right-hand sectional view. The mercury then runs to the other end of the tube leaving one electrode bare and the circuit is opened without cutting a wire.

BATTERY HOLDER.

A simple and efficient form of apparatus by which dry batteries may be held together and easily connected is shown in the cut.



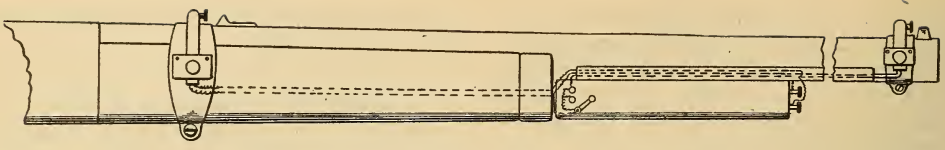
BATTERY HOLDER

The frame or support overlying the batteries is provided with spring clips on the under side which slip over the battery terminals and make contact and save all the cumbersone wiring between cells. The inventor is Charles T. Mason of Sumter, S. C.

ELECTRIC GUN SIGHTS.

The sighting of fire arms at night is a matter of considerable importance and even now our army experts are making exhaustive tests of devices which will permit this to be done. A recent patent along this line is one taken out by Emil O. Deere and Thure O. Jaderbörg, both of Lindsburg, Kansas.

As shown, the gun is provided, in the neighborhood of the front and rear sights, with two tiny electric lamps which are fed by a battery cell fastened underneath the barrel. These lamps are not placed there to illuminate the regular sights but the

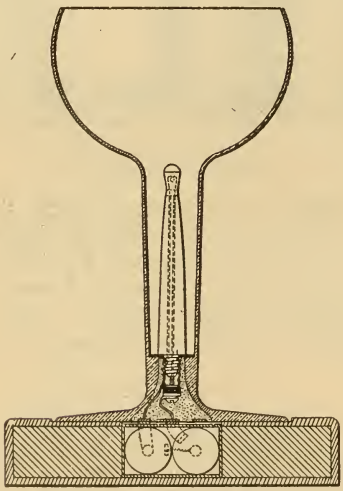


ELECTRIC GUN SIGHTS

lamps themselves act at the sights at night. They shine as two bright sparks in the darkness, and the two are simply brought in alignment with the target in aiming.

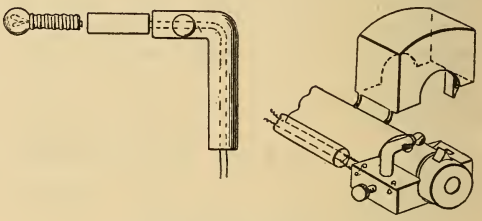
ELECTRICALLY ILLUMINATED DRINKING GLASS

A novel and pleasing effect may be produced by the electrically illuminated drinking glass shown in the cut. The glass is provided with a long hollow stem in which is placed a miniature electric lamp as shown. This is attached to the end of a pedestal in the stem, and the lead-in wires to the lamp pass up through this pedestal. Electrodes projecting out from the bottom of the



ELECTRICALLY ILLUMINATED DRINKING GLASS

glass make contact with the terminals of a battery placed in a special base. When the glass is set down on this base the lamp is lighted, giving great brilliancy to the liquid. When the glass is lifted from the base the lamp of course goes out. The inventor is Joseph H. Cahill of St. James, N. Y.



ELECTRIC ANIMAL TRAP.

A unique device for killing wild animals by means of dynamite or other high explosives is the invention of Martin O. Cox of Tygh Valley, Oregon. A dynamite cartridge with an electric exploding device is cunningly hidden in a piece of bait. A double wire for the battery circuit leaves the cartridge and runs to a point some distance away. Here it divides, one wire of

ELECTRIC ANIMAL TRAP

the circuit passing through a coiled spring circuit-closing device to one side of the battery. The other wire goes direct to the other side of the battery. When the animal seizes the bait and attempts to drag it away the spring is stretched sufficiently to bring the two open contacts inside together, closing the circuit and sending off the charge.

Within the past few years electricity has been utilized to produce some of the most remarkable stage pictures it is possible to conceive. Without the faithful agency of electricity the theatre would lose half of its scenic attractions.

THE TELEPOST.

Several inventors have in the past devised machinery that would automatically transmit telegraph messages at high speed, and as early as 1879 one of the systems was put into experimental operation. Unfortunately for these earlier inventions, the electricians were unable to cope with their arch-enemy, the "static" charge of a telegraph wire. Atmospheric changes, induction currents and other disturbances also interfered persistently with their operation. But finally Mr. Patrick B. Delany, an expert electrical engineer and the inventor of many telegraphic improvements, announced that he was going after "static," as he believed the problem could be solved by patient effort.

He devoted himself with determined energy to experiments which he hoped would make him master of the principle. He devised new mechanisms and applied new theories to the working out of a system that occupied him for fifteen years before he finally discovered how to deal with "static" (which may be described to the lay mind as the excess electricity with which a wire is saturated, and which must be "cleared" before signals can be sent. It is a very tricky element.) In 1903 he obtained from the United States Government a basic patent on his invention for the control and use of the "static."

PERFORATING THE SENDING TAPE

Remarkable as Mr. Delany's achievement is from a scientific viewpoint, its real importance lies in the fact that it bids fair to clear the way for the almost inestimable boon of cheap telegraphy. The ability to send telegrams at the rate of one thousand words a minute means that the Telepost, as the device is called, can transmit over one wire as many messages as the ordinary telegraph can transmit over seventeen wires. Which is assuming that the methods at present in use permit the sending of sixty words a minute on an average.

There are many notably interesting features about the Telepost beside its speed and cheapness. It has, for example, three quite unique services in addition to that of transmitting regular telegrams. One of these is "telecarding," which is sending a postcard by wire. Though this is not done literally, it is in effect thus: The writer fills in a "telecard" (the same size as a postcard) and hands it in to the Telepost office (or he can drop it into a post-office box to be delivered in due form by the letter-carrier), and the Telepost will wire the message to the point of destination or to the nearest Telepost office to that point, where it will be typed onto a similar card addressed to the person for whom it is intended, and delivered through the mails. By this means "telecard" messages could be written in New York and be delivered to an address in Chicago in two hours, instead of in the twenty or thirty hours required to transport a postcard between the two cities.

Another and somewhat similar service is the handling of a fifty-word letter in the same way, at a nominal charge. The letter is handed in, or sent by mail, to the local Telepost office. The operator there transmits it to the city of destination by wire, where it is typewritten, put in an envelope, properly addressed, and dropped into the postoffice for delivery by the local carrier.

But the service that is most interesting in the point of novelty, and which will prove of especial value to the business world and to those who wish to secure the utmost privacy for their messages, is the "teletape," by means of which one-hundred-word messages can be sent for a few cents, even from Boston to San Francisco. That the reader may understand this device, it must be explained that all messages transmitted by the Telepost's rapid automatic system are,

before being fed into the transmitter, perforated on a narrow paper tape by a perforating machine operated by a lettered keyboard very like that of the typewriter.

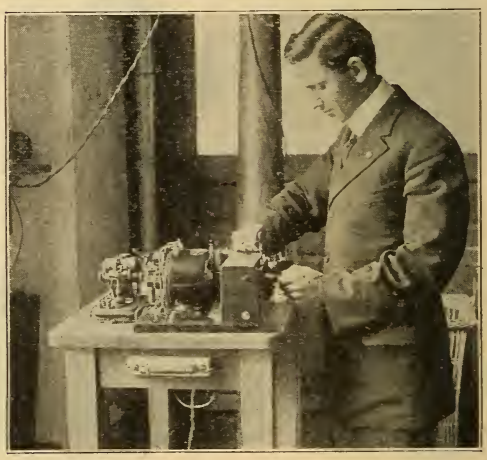
OPERATOR REMOVING SPOOL OF MESSAGES

This machine may be worked at any speed at which a person is capable of manipulating the keyboard, and the message can thus be prepared by anyone, a knowledge of telegraphy not being necessary to its use. The tape so perforated—the perforations being regulated to the dot and dash signals—is fed at the speed of one thousand words a minute.

The advantage of the "teletape" to the business man is that he can have a perforating machine in his own office, just as he has a typewriting machine, and he, or his stenographer for him, can prepare his own types, and can, if he chooses, employ a cipher code in doing so. When the tape is ready he has only to write the name and address to which it is to be sent, sign his name or code word, and send it by his office-boy to the Telepost office. There the operator takes the "teletape" and simply feeds it into the automatic transmitter, and has nothing else whatever to do with the message. At the receiving station the message is electrically printed on a tape in dots and dashes, which is delivered just as it is to the address indicated, where it is first translated by the person for whom it was intended. As anyone of ordinary intelligence can, with a few hours' study, learn the dot and dash alphabet, the recipient of these "teletapes" or his stenographer, will quickly be able to read them off as readily as if they were printed in Roman type.

This feature makes strong appeal to business men, and already firms in cities where the Telepost has begun operating are making application for perforating mochines to be installed in their offices. The supremacy of the Telepost system does not rest on a theoretical claim. Continuous operation through the past winter, over a line stretching from Boston to Portland, Me., demonstrated anew the previously fully established claims of the Telepost as "a means of furnishing rapid and uninterrupted telegraphic communication."

After some months' successful operation commercially in the East the first western Telepost section has been opened up. With



OPERATOR TRANSMITTING MESSAGES BY TELEPOST

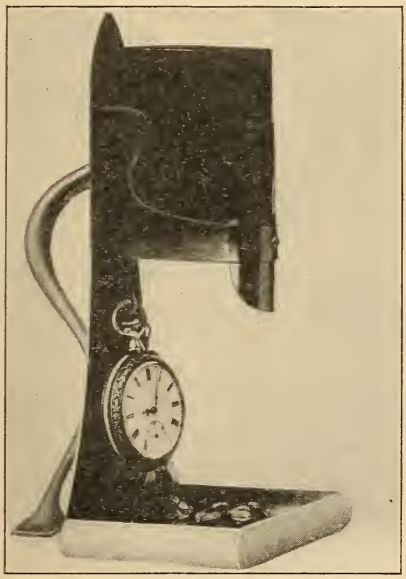
St. Louis, Missouri, as a center, much progress has been made in several directions. The St. Louis-Kansas City line has reached Sedalia, Mo. The St. Louis-Indianapolis line is now at Terre Haute, Indiana, and the St. Louis-Chicago line is nearly completed. Telepost offices are now equipped in St. Louis, Kansas City, Terre Haute, Ind., and Springfield, Ill., and other important points on these lines will shortly be connected up so that it is announced that in the immediate future these cities will be enjoying Telepost service.

The Telepost has already done enough to give practical significance to the descriptive phrase used a few months ago by a distinguished Congressman in describing it as "the telegraph of the future."

TO SEE YOUR WATCH AT NIGHT.

A new type of holder for a watch has recently been put on the market in Germany. The principal feature is that a pocket electric lamp is used for lighting the dial.

As can be seen in the cut the hook for the watch is mounted on a bracket which firmly holds the pocket battery with its little electric lamp in the end. The button for closing the battery circuit rests upon the bracket, but the weight of the battery is not sufficient to push the button towards the inside and close the contact. It is only when we place



WATCH ILLUMINATOR

the hand on the top of the battery that the button is pushed in and the lamp will be lighted. The upper part can be taken out if desired and used as an ordinary pocket electric lamp.

With this outfit we need not search in the darkness for a button or contact lever, but simply place the palm of the hand upon the whole apparatus and the lamp will instantly glow. The form illustrated is used for the table, others have been devised for the wall. The shield in front serves as a reflector to throw the light upon the dial of the watch and to protect the eye from direct light.

A wireless plant will be installed on the top of the tower of the city hall of Philadelphia, 500 feet above the street.

BOOK REVIEWS

ELECTRIC RAILWAY POWER STATIONS. By Calvin F. Swingle. Chicago: Frederick J. Drake & Co. 1909. 701 pages with 368 illustrations. Price, $2.00.

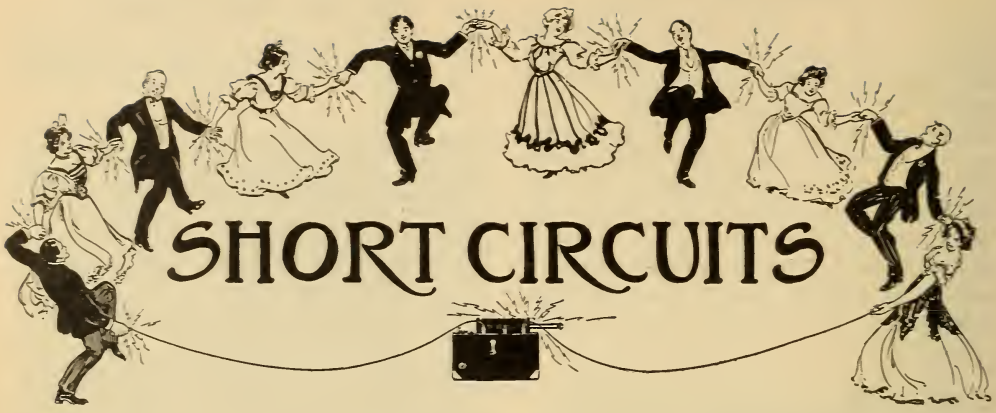
The electric railway power station is treated in a plain practical manner from the standpoint of the operating engineer rather than the designer. The complete power station equipment is treated in logical sequence beginning with the entrance of the coal into the boiler room and ending with the exit of its contained energy in the form of electricity from the station switchboard. It teaches the engineer what he ought to know regarding different kinds of coal handling apparatus, stokers, boilers and steam engines, including the steam turbine. Then the electric generators are taken up, and their various parts described. Finally station switchboards are discussed, switching devices, instruments, etc. An educational feature of the book is a collection of questions and answers following each chapter which bring out the features discussed.

WIRELESS TELEGRAPHY AND TELEPHONY. By Walter W. Massie and Charles R. Underhill. New York: D. Van Nostrand Co. 1908. 75 pages with 28 illustrations. Price, $1.00.

This is an explanation, in simple language, of the theories leading up to the present development in the art of wireless telegraphy and telephony, also descriptions of the leading systems in use today. Some interesting historical data is also appended concerning the early attempts to make wireless telegraphy practical.

APPLICATION OF ELECTRIC MOTORS TO MACHINE DRIVING. (Third Edition.) By Andrew Stewart. London: S. Rentell & Co., Ltd. 1905. 131 pages with 92 illustrations.

After first describing in a general way the construction, operation and characteristics of the electric motor, examples are given of the various applications of the motor to machine drive. There are described applications of the motor in the shop, on the farm, in the home, in the railroad yard, the printing establishment, etc. With the extension of motor applications has come an increasing appreciation of their advantages. It has been the author's aim, therefore, not only to illustrate the various applications of electric drive, but to further increase this appreciation by indicating the economic advantages gained.



"Jackie," said the boy's mother, "your face is fairly clean, but how did you get such dirty hands?"

"Washin' me face," said the boy.

* * *

Canvasser—"Madam, I would like to show you the beautiful silver forks that we are giving away with every half dozen bars of Skinflint soap."

Lady of the House—"We don't never eat with no forks in this house. They leak."

* * *

"You say you were in the bar at the time of the assault referred to?" asked the lawyer.

"I was, sir."

"Did you take cognizance of the landlord at the time?"

"I don't know what he called it, but I took what the rest did."

* * *

An old lady appeared in church one Sunday with an ear trumpet. Her presence seemed to worry one of the ushers who had never seen one of these instruments before. Being a devout Scotchman he apparently came to the conclusion, at last, that something might happen unbecoming to the sanctuary, so he tiptoed up to the old lady and in a loud whisper announced: "One toot and you're oot."

* * *

It was in the hotel of a Western mining town that the New England guest, registering in the office, heard a succession of loud yells. "What in the world is that—a murder going on upstairs?" he demanded.

"No," said the clerk, as he slammed the book and lounged toward the stairs. "It's the spring bed up in No. 5. That tenderfoot up there don't get the hang of it, and every few days he gets one o' the spiral springs screwed into him like a shirt stud. I guess I'll have to go up; there ain't anything more I can do for you for a few minutes."

* * *

"In Chicago one evening," related the college son back home, "as I was passing beneath a gas lamp I beheld the form of my old college room-mate silhouetted on the snow!"

"I ain't surprised," exclaimed Aunt Martha shuddering. "In that awful city they even murder people on the street in broad daylight!"

* * *

The father frowned.

"What is that boy watching all the clocks for?" he demanded.

The mother smiled.

"He's got them running in a six-day Marathon race," she replied, "and the one that runs the longest gets oiled."

"Judge, did you ever try an absinthe frappé?"

"No; but I've tried a lot of fellows who have."

* * *

Drink to me only with thine eyes
And I will pledge with mine;
For I see six germs within the cup
So I do not care for the wine!

* * *

"I suppose," said the casual acquaintance, the day after the wedding, "it was hard to lose your daughter."

"No," replied the bride's father. "It did seem as if it was going to be hard at one time, but she landed this fellow just as we were beginning to lose all hope."

* * *

This story would seem to show that colored people have tough heads:

Dinah, crying bitterly, was coming down the street with her feet bandaged.

"Why, what on earth's the matter?" she was asked. "How did you hurt your feet, Dinah?"

"Dat good fo' nothin' nigger (sniffle) done hit me on de haid wif a club while I was standin' on de hard stone pavement."

* * *

The Poet—Is there a literary club in this vicinity?

The Editor (reaching behind the desk)—There is. Are you literary?

* * *

"But why should we grant a pension to this California state senator for throat affection?" inquired the minority leader of the committee on pensions.

"Because it's the result of ponderous platitudes uttered during the war between California and Japan!" replied the chairman.

* * *

"Doin' any good?" asked the curious individual on the bridge.

"Any good?" answered the fisherman, in the creek below. "Why, I caught forty bass out o' here yesterday."

"Say, do you know who I am?" asked the man on the bridge.

The fisherman replied that he did not.

"Well, I am the county fish and game warden."

The angler, after a moment's thought, exclaimed, "Say, do you know who I am?"

"No," the officer replied.

"Well, I'm the biggest liar in eastern Indiana," said the crafty angler, with a grin.

* * *

Mrs. Jenner Lee Ondego—"Did you feel that earthquake shock this morning?"

Mrs. Seldom Holme—"Very distinctly; but I thought it was my husband getting out of bed."

ELECTRICITY IS LIFE
WHAT IS ELECTRICITY?
PROF. DINGBAT, BIOLOGIST.
ELECTRICITY IS JUICE. FARE PLEASE
WHAT IS ELECTRICITY?
-STREET CAR CONDUCTOR-
ELECTRICITY IS WHAT GENERAL WHATS-HIS-NAME CALLED WAR. THE WORD IS SHORT AND STARTS WITH A CAPITAL H.
HAW!
WHAT IS ELECTRICITY?
THE MAN WHO PLAYED WITH A LIVE WIRE AND ESCAPED ALIVE
SURE I KNOW WHAT IT IS. I MADE A LIFE-LONG STUDY OF IT, AND HAVE PREPARED A SERIES OF CHARTS THAT ENTIRELY EXPLAIN JUST WHAT IT IS
FIG 1
FIG 2
FIG 3
CHART NO 1
PROF. BUGGE C.Q.D. UNIVERSITY OF DUNNING
ELECTRICITY? OH-A-SURE. IT'S-A-OH-SAY BY THE WAY DID YOU READ WHAT WAGNER DID YESTERDAY? HE WAS AT BAT AND ETC., ETC.
WHAT IS ELECTRICITY?
-BASE BALL FAN-
ELECTRICITY IS A POWERFUL PHYSICAL AGENT WHICH MAKES ITS EXISTENCE MANIFEST BY ATTRACTIONS AND REPULSIONS, BY PRODUCING LIGHT & HEAT, COMMOTIONS, CHEMICAL DECOMPOSITIONS AND OTHER UNIQUE MUNDANE PHYSICAL PHENOMENA
C. DE BALL
GRADUATED FROM HIGH SCHOOL LAST SPRING.

WHAT IS ELECTRICITY?

ELECTRICAL DEFINITIONS

Below are defined a few of the most common electrical terms. They are reprinted from month to month and will be of assistance in understanding the magazine text.

Accumulator.—See secondary battery.

Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.

Ammeter.—An instrument for measuring electric current.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt. The international ampere is the current which, under specified conditions, will deposit .001118 gram of silver per second when passed through a solution of nitrate of silver in water.

Ampere Hour.—Quantity of electricity passed by a current of one ampere flowing for one hour.

Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.

Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.

Brush.—The collector on a dynamo or motor which slides over the commutator or collector rings.

Bus Bars.—The heavy copper bars to which dynamo leads are connected and to which the outgoing lines, measuring instruments, etc., are connected.

Buzzer.—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.

Candle Power.—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.

Capacity, Electric.—Relative ability of a conductor or system to retain an electric charge.

Charge.—The quantity of electricity present on the surface of a body or conductor.

Choking Coil.—Coil of high self-inductance which retards the flow of alternating current. See self-inductance.

Circuit.—Conducting path for electric current.

Circuit-breaker.—Apparatus for automatically opening a circuit.

Collector Rings.—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.

Commutator.—A device on a dynamo shaft for gathering the current from the various coils of the armature and sending it out over the line as direct current. On a motor it takes current from the line and passes it on to the armature coils.

Condenser.—Apparatus for storing up electrostatic charges.

Cut-out.—Appliance for removing any apparatus from a circuit.

Cycle.—Full period of alternation of an alternating current circuit.

Dielectric.—A non-conductor.

Dimmer.—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.

Direct Current.—Current flowing continuously in one direction.

Dry Battery.—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.

Electrode.—Terminal of an open electric circuit.

Electromotive Force.—Potential difference causing current to flow.

Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.

Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.

Farad.—Unit of electric capacity.

Feeder.—A copper lead from a central station to some center of distribution.

Field of Force.—The space in the neighborhood of an attracting or repelling mass such as a magnet or a wire carrying current.

Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.

Generator.—A dynamo.

Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.

Insulator.—Any substance impervious to the passage of electricity.

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

Leyden Jar.—Form of static condenser which will store up static electricity.

Lightning Arrester.—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.

Motor-dynamo.—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa, or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.

Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.

Neutral Wire.—Central wire in a three-wire distribution system.

Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in height.

Parallel Circuits.—Two or more conductors starting at a common point and ending at another common point.

Polarization.—The depriving of a voltaic cell of its proper electromotive force.

Potential.—Voltage.

Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.

Rheostat.—Resistance device for regulating the strength of current.

Rotary Converter.—Machine for changing high-potential current to low potential or vice versa.

Secondary Battery.—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.

Self-inductance.—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.

Series.—Arranged in succession, as opposed to parallel or multiple arrangement.

Series Motor.—Motor whose field windings are in series with the armature.

Shunt.—A by-path in a circuit which is in parallel with the main circuit.

Shunt Motor.—Motor whose field windings are in parallel or shunt with the armature.

Solenoid.—An electrical conductor wound in a spiral and forming a tube.

Spark-gap.—Open space between the two electrodes of a spark coil or resonator.

Storage Battery.—See secondary Battery

Thermostat.—Instrument which, when heated, closes an electric circuit.

Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

Volt.—Unit of electromotive force or potential. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

Volt Meter.—Instrument for measuring voltage.

Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.

Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.

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The next and following pages contain:

Price, Terms and Conditions
Personal Statements by Frank O. Balch
Opinion of the "American Banker"
A few Names of Chicago Stockholders
Fourteen Reasons
Application Blank and

Complete Information, consisting of

Profits in Magazine Publishing
A Brief Story of Home Life
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This offering is sufficiently unusual to require immediate attention.

Turn to next page

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The American Banker

May 9, 1909, editorially analyzing this investment, says:

"————to the American Banker it seems a most unusually fair and clean opportunity to earn at least 10%, and most likely more, on an investment now showing at a conservative valuation a book value of 62% in excess of the price asked for the shares, and bound to increase in market value as the improvements in the magazine and plant are consummated. Bankers can safely take advantage of and recommend the Balch Publishing Company's shares as an investment."

$40,000 Has Already Been Subscribed

and among the Chicago subscribers personally acquainted with Frank O. Balch and the Home Life Magazine are the following:

T. C. FREDERICK,
Treasurer Bedford Quarries Co.

GEO. GILLETTE,
Attorney

H. A. BINGHAM,
Pilcher-Hamilton Paper Co.

H. A. BOWMAN,
President Bowman Auto. Addressing Co.

JOHN ARTHUR DIXON,
Chicago Record-Herald.

ALFRED BERSBACH,
Treasurer Manz Engraving Co.

JOHN HINDMAN,
President Colonial Mercantile Co.

ARTHUR E. SWETT,
Swett Advertising Agency.

E. C. BODE,
Advertising Manager Chicago Examiner.

H. E. GROTH,
Treasurer Mahin Advertising Co.

E. L. KUNZE,
Insurance.

R. C. HARRELL,
President Steamfitters' Supply Co.

W. A. C. SMITH,
Manager The Ohio Quarries Co.

WM. A. WADSWORTH,
Manager Popular Electricity Magazine.

Frank O. Balch

President of the Balch Publishing Company, submits the following personal statements:

Bearing upon the 10 per cent preferred stock of the Balch Publishing Company, I submit the following:

No one is as competent to know your character as the man who comes into daily contact, does business with you and extends you credit. I started in the publishing business in Chicago nine years ago and am dealing with the same firms today as at the start. I have built up the business from practically nothing under the standard that carries no regrets in its trail, and permits of traveling the same paths certain of encountering the same uniform welcome.

My own good faith is amply evidenced by the fact that I have turned over the entire property to the company for only $50,000 in stock (or one-third of the entire capital stock of $150,000, thereby surrendering control to the public), although it is considered to be worth a good deal more. In doing so I was prompted by a realization that with additional capital of $100,000 the profits can be increased sufficiently to make my third interest pay me and be worth more than the entire ownership as heretofore.

A bank is a stock company with the privilege of receiving deposits. A business corporation is a stock company without the privilege of receiving deposits. Both have the privilege of selling their stock, and both can be either sound or unsound. A bank having resources of $290,000, liabilities of $200,000, and a surplus of $90,000, is considered sound and prosperous. A business corporation making a similar showing is considered equally prosperous and sound. The figures are taken from the last trial balance of the Balch Publishing Company (May 1, 1909).

Money deposited in a bank may be withdrawn at any time, but it draws only 3 per cent a year. Money invested in the Balch Publishing Company cannot be withdrawn for three years, but it pays at least 10 per cent a year.

While banks are always ready to receive deposits and investments of various character always available, the information submitted herewith will convey to the intelligent investor the rarely encountered advantages and qualities of this offering.

The ground is thoroughly covered in this announcement, and I can only reiterate the facts which in assembly serve to make the investment unusual and desirable:

The business has been in successful operation for years. The value of the stock is real and ample. The profits are actually earned now. The dividends are payable, the same as bank or bond interest, every six months from the date of the certificate, and at least 10 per cent a year is guaranteed. The future is not discounted, imagination not drawn upon, success accomplished by others not considered a criterion, only what we ourselves *have done and are doing*, forms the basis of the entire proposition.

Respectfully submitted, FRANK O. BALCH.

Fourteen Reasons Why

the Home Life Shares constitute the strongest industrial investment at present available to the public:

1—The principal is guaranteed.

2—Annual dividends of at least 10 per cent are guaranteed.

3—The earnings are several times as large as the amount required to pay 10 per cent on the entire 10,000 shares. The discounts alone should be sufficient to meet the dividend requirements.

4—While the business shows earnings at the rate of 6 per cent on $1,000,000, and is estimated to be worth $450,000, it is capitalized only for $150,000.

5—The Company is incorporated under the laws of the State in which it is doing business.

6—The business is well established, successful and paying.

7—There is no promotion stock.

8—The entire amount of money realized from the sale of stock, less the actual expense of selling it, goes into the business.

9—With the additional investment of the money realized from the sale of the shares the earnings are expected to be considerably greater than at present.

10—The books of the Company are at all times open to interested parties.

11—The business is known practically throughout the United States, and every claim can be substantiated.

12—Every phase of the proposition is exactly as represented, and every facility for corroboration will be afforded. Whatever point of view it may be judged from, the investment is of a character rarely, if ever, offered to the public. The business is conducted with the same care and economy as any successful business man would conduct his individual affairs.

13—On a 10 per cent basis with earnings of about 40 per cent the shares may be considered to be worth $40.00 each. Their value will increase proportionately with the earnings.

14—Each $10 share is guaranteed $1 a year in dividends and may be expected to earn considerably more as the expense incidental to improvement and maintenance diminishes.

Complete Information

is submitted below. The Balch Publishing Co. is an Illinois corporation, located in Chicago, at the corner of Kinzie St. and Dearborn Ave., directly opposite the Dearborn St. bridge. Receipts from the Chicago Post Office are cited. References are published from a few of the largest and oldest firms in their respective lines in Chicago. Figures are given and the books are in Chicago. The business has been under the same management for nine years. It is favorably known to every one prominently connected with the advertising and publishing business.

Profits in Magazine Publishing

Frank A. Munsey started in the magazine business with a capital of $40; his business now pays a profit of $1,000,000 a year. The stock of the S. S. McClure Company is worth $1,000 a share. The income of the Curtis Company from the Ladies' Home Journal and the Saturday Evening Post is nearly $6,000,000 a year. The annual income from the Cosmopolitan Magazine is about $1,500,000. The property is now owned by William Randolph Hearst, who bought it from John Brisben Walker. Mr. Walker had made several fortunes from the magazine. The profits of Everybody's Magazine are estimated as being as high as $800,000 a year. Other American magazines are all large profit earners. A well-known English author about ten years ago accepted $2,000 worth of McClure's stock in payment for a story; recently he sold the stock for $20,000. During the time when he held the stock it paid him dividends of $14,000, making a total of $34,000 cash for $2,000 worth of fiction manuscript. If you had been able to secure an investment of only $100 in Munsey's Magazine that investment would now be paying an income of $1,000 every year and would be worth at least $10,000 in cash. Those who had the opportunity to become interested with magazines when they first offered their stock to the public have become wealthy. I

A Brief Story of "Home Life"

Home Life was established 19 years ago at Caro, Michigan. Mr. Balch became connected with it in 1900 and moved the magazine to Chicago. In September, 1900, it had a circulation of 20,000, at the end of five years 500,000, and now the circulation of Home Life is 900,000 copies each issue, mailed direct every month into the homes of 900,000 laboring and farming American families residing in the rural districts, and read by more than four million people. It is not sold on news stands and has no waste circulation. The advertising rate of Home Life is $3.60 per single column line, or $1,764 per page, which is higher than Collier's, Munsey's, McClure's, Everybody's, etc., and exceeded only by five magazines in the United States. It makes no claim to beauty in appearance and is not in the class of ornamental magazines—just a substantial 25-cents-a-year, "2-cents-a-copy" mail order publication for the masses, and a dependable source of profit to its advertisers and publishers.

Among the contributors are: Rev. Dr. Frank W. Gunsaulus, President of the Armour Institute of Technology, who furnishes editorials and special monthly articles; Robert W. Chambers, Bishop Samuel Fallows, Opie Read, Cyrus Townsend Brady, Robert B. Armstrong, Elia W. Peattie, Charles Noel Douglas, S. E. Kiser, Richard Henry Little, Carolyn Wells, etc. Among the numerous advertising patrons are: Lyon & Healy, Sears, Roebuck & Co., Chicago, Milwaukee & St. Paul R. R., National Biscuit Co., Kimball Pianos, John M. Smyth & Co., Mead Cycle Co., Hartman Furniture Co., Crofts-Reid Co., etc., etc. All advertising orders are received through and bills paid by advertising agencies with established credit.

Balch Publishing Company

Home Life is owned and published by the Balch Publishing Company, incorporated under the laws of the State of Illinois. The authorized capital stock is $150,000, divided into 15,000 shares of $10 each. $50,000, or 5,000 shares, are common stock, and $100,000, or 10,000 shares, are preferred stock to the extent of 10 per cent. The $50,000 of common stock constitutes the consideration for which Mr. Frank O. Balch transferred the entire property to the Company, and the $100,000 of preferred stock is offered for investment. While the preferred stock is guaranteed only 10 per cent of the profits it participates in and is entitled to receive its full share of the additional profits, the same as the common shares.

Present Condition of the Company

The following figures are taken from the trial balance for the four months of the present fiscal year:

The income during the said period of four months was $109,735.46, the expenses for the same period $88,138.25, and the earnings $21,597.12, which is at the rate of $5,399.30 per month, equal to 43 per cent on the entire capital of $150,000, and six times as large as the guaranteed annual dividend.

As per trial balance of May 1, 1909, the resources of the Company are $291,545.54, the liabilities (inclusive of the capital stock) $199,781.51, and the surplus $91,764.03.

The receipts from the Chicago Post Office on file at the office of the Company show that over 900,000 copies of Home Life are mailed monthly.

The value of a magazine is figured on a basis of $2.00 per circulation unit, which would make Home Life, with its 900,000 circulation, worth $1,800,000, or twelve times the amount of the Company's capitalization. Even on the basis of 50 cents per unit the magazine would be worth $450,000; on the books of the Company, however, circulation is valued at only about 16 cents per unit.

The Purpose

The purpose for which the stock is offered is to secure funds to improve Home Life to the extent of making it the leading rural publication in this country. The population of the United States is eighty-four millions, of which seven millions are classes and seventy-seven millions are masses—the field of Home Life is with the masses. The stock is offered to the public because the security, while ample, is not of the class on which banks are permitted to make loans, and large or short term loans from individuals are not advisable. It should be understood, however, that while additional capital is desirable and will enable the Company to make immediate improvements, the business is sufficiently well established to continue profitable regardless of the sale of stock.

Outline of Improvements

The first improvement will consist of discounting all bills, which discounts are expected to be sufficient to pay the guaranteed 10 per cent interest on the entire issue of $100,000 worth of preferred stock.

The next improvement will consist of using a higher grade of paper for the magazine, better cover designs and superior reading matter.

The third improvement will consist of eliminating all objectionable advertising. To secure higher grade advertising, such as is carried by the Ladies' Home Journal and other standard publications, the objectionable advertising has to be eliminated for about two months, as the higher grade advertisers are particular of the company in which they appear. New, substantial advertisers can easily be secured, owing to the fact that Home Life is known to be very near the top as a paying publication for advertisers. The proceeds from the sale of the preferred stock will provide the necessary strength to effect the above improvements with safety.

After the mentioned three improvements are accomplished and the magazine made the best and strongest publication for the masses in the country, the fourth improvement will be introduced, consisting of raising the price of Home Life from 25 cents to 50 cents per year, which, on the basis of the present circulation, will increase the income from that source alone by $225,000 a year, equal to 150 per cent on the entire capital of the Company.

Guarantee

An indorsement upon each certificate guarantees the payment of at least 10 per cent dividends, payable semi-annually, and the redemption of the principal with a premium of 5 per cent on demand at the end of three years. The entire assets of the Company and Mr. Balch's personal estate are back of the guarantee, which is as effective as a first mortgage, there being no bonds, mortgages or prior liens of any kind. In addition to the security represented by the business, Mr. Balch's life is insured in the Penn Mutual Life Insurance Company for the benefit of the preferred shareholders to guard against the value of the business being impaired temporarily or permanently through his unexpected decease. The surrender of the shares, however, is not obligatory, being left at the option of the shareholders.

References

The magazine is known to every one prominently connected with the publishing or advertising business. It is known to 900,000 homes in the United States. It is listed as one of the leading mail-order monthlies in every newspaper and magazine directory, and the Company receives business from nearly every advertising agency in the country. A few specific Chicago references are submitted herewith and many others can be furnished on request.

March 5, 1909.

We have had business dealings with the Balch Publishing Co. for several years, and our relations have been very satisfactory.

We regard them as a reliable and progressive concern and any statements that they make are worthy of consideration.

THE PILCHER-HAMILTON CO.,
1824 Dearborn Ave.

We desire to advise you that we are greatly pleased with the results our customers are getting from Home Life.

The best evidence of our appreciation of the merits of your publication is the fact that during 1908, which was a panicky year, our business, with you increased 262 per cent over 1907. Yours very truly,

MAHIN ADVERTISING CO
125 Monroe St.

March 5, 1909.

TO WHOM IT MAY CONCERN:

We have known Mr. F. O. Balch, publisher of the Home Life and Ladies' Magazine, since the year 1900. We have been doing business with him continuously since then, and we believe that to him alone is due the credit for building up the business to its present large proportions. BRADNER SMITH & CO.,
134 Monroe St.

March 4, 1909.

Balch Publishing Co., 205 Kinzie St.

Gentlemen—We are glad to say to you and all who are interested, that we greatly admire the manner in which you conducted your business and the sincerity with which you have met your obligations during the present financial stringency. We highly regard your Mr. Frank O. Balch and believe him to be an exceptionally honorable and hard-working young business man. Very truly yours,

MANZ ENGRAVING COMPANY.
Majestic Building.

March 5, 1909.

Referring to your investment proposition in the stock of Balch Publishing Co.

It is a well-known fact that the larger the scale any business proposition is conducted on, the less expensive it is pro rata. For this reason it does appear to me that the stock proposition you offer the public should be a most excellent one. Nelson Chesman & Co. are already spending with you for our clients in the neighborhood of from $50,000 to $75,000 per year, and the fact that the character of business which applies to your publication is constantly increasing, there is no reason why we should not in the next year or two be able to spend with you double the amount. Other agencies will undoubtedly be in the same position as ourselves, and altogether we think your investment proposition a good one. Yours very truly,

NELSON CHESMAN & CO.,
Owners of Publicity Bldg., St. Louis. Chicago Office: Trude Bldg.

March 12, 1909.

At your request we are submitting you herewith a statement showing the value of paper you have purchased from us since October, 1908, for your publication, Home Life.

October, 1908	$ 4,994.01
November, 1908	4,522.83
December, 1908	5,032.58
January, 1909	5,826.98
February, 1909	5,882.84
Total	$26,259.24

We desire to assure you that your account is fully appreciated and that we are at all times ready to cooperate with you in maintaining the success of your magazine. Yours very truly.

BERMINGHAM & SEAMAN CO.,
Tribune Building.

Supervision of Business

The Company, being a home enterprise, more or less public, located right here in Chicago, within five minutes' walk from the loop, it would be easy for any one interested to keep posted on progress and conditions, and as the magazine would be mailed each month to every shareholder, knowing the advertising rate to be $3.60 per line, it can always be figured out how much income is derived every month. Complete statements will be sent to all shareholders semi-annually with the dividend checks.

Conclusion

The investment is presented and will appeal only to the man who realizes that he has no money to lose in purely speculative enterprises; to the deliberate man, who in making his investments requires a clean record of success and indisputable reference upon the integrity and ability of the institution to which he entrusts his money; to the man desirous of realizing more profit on his money than savings banks or first mortgages pay, and yet not grasping enough to sacrifice safety to a mere "prospect" of big profits.

In presenting this investment to the public no inducements other than merit are offered. The investment is advantageous as it stands, and its advantages are due to the fact that the Company is capitalized for only as much as it needs, which in turn is due to a desire on Mr. Balch's part to continue the business as heretofore, producing profits from its legitimate sources and not from the sale of securities to the public. The Company is a comparatively uncomplicated affair, and all there is to the proposition is told in this announcement. The entire issue consists of 10,000 shares only, over 4,000 have already been sold, and it is anticipated that the remainder will be promptly subscribed. It is therefore recommended that applications be sent in promptly to secure the shares at $10. The attached blank can be used in applying for shares, and the application with payment should be made or mailed before July 15 to be entitled to a credit of two months' dividends.

The entire information presented in this announcement constitutes the basis upon which these shares are offered for subscription, and it is made a part of the application as if embodied therein.

BALCH PUBLISHING CO.

Use This Application Blank

Balch Publishing Company,
51 Dearborn Avenue, Chicago, Ill.

Subject to your guarantee, I herewith apply for.....Shares of your 10 per cent Guaranteed Preferred Stock at $10 per share on Plan.....and enclose herewith $..... as required under the said plan, agreeing to pay the balance, if any, according to your terms.

Issue and mail me certificate or receipt, as I am entitled to by my payment. In the event of my application reaching you too late to secure the shares at $10, you will advise me and be governed by my instructions. Mail me a current copy of Home Life and a copy of each issue thereafter.

Name .....

Address .....

N. B. If application is accompanied by full payment certificate will be issued immediately. If part payment is sent, regular receipt will be mailed and certificate issued when payments are completed.

CLASSIFIED ADVERTISING

Rates, 40 cents per agate line, cash with order, nothing less than 3 lines.
Advertisements should be in our office on or before the 2d preceding date of issue.

HELP WANTED

WE EXPECT to have positions for a number of men as automobile car drivers, and interurban railways; only sober and reliable men need apply; experience unnecessary; send four-cent stamp for applications. The Western Transportation Company, American Nat. Bank Bldg., St. Paul, Minn.

WANTED—Railway mail clerks, city carriers, postoffice clerks. Many examinations coming. Yearly salary $600 to $1,600. Short hours. Annual vacation. No layoffs. Salary paid twice monthly. Over 8,000 appointments to be made during 1909. Country residents eligible. Political influence not necessary. Common education sufficient. Candidates prepared free. Write immediately for schedule of coming examinations. Franklin Institute, Dept. F 62, Rochester, N. Y.

THE UNITED TRADE SCHOOL CONTRACTING CO., conducts a trade school and wants men to learn plumbing, bricklaying or electrical trade. No expense and hundreds have learned in a few months. Steady work guaranteed. Address 120 E. 9, Los Angeles.

PATENTS

PATENTS—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an investigation and report if patent can be had, and the exact cost. Send for full information. Trade-marks registered.

PATENTS—Advice and books free. Highest references. Best results. I procure patents that protect. Watson E. Coleman, Patent Lawyer, 612 F St., N. W., Washington, D. C.

PATENTS SECURED — Inventor's Pocket Companion free. Send description for free opinion as to patentability. W. N. Roach, Jr., Metzerott Bldg., Washington, D. C.

SCHOOLS

$200 TO $600 MONTHLY EASILY MADE fitting eye glasses. Short, easy mail course. Reduced tuition. Big demand for opticians. Write today for free "Booklet O." National Optical College, St. Louis.

TELEGRAPHY taught quickly. R. R. wire in school. Living expenses earned. Graduates assisted. Correspondence course if desired. Catalog free. Dodge's Institute of Telegraphy, 49th St. Valparaiso, Ind. Established 1874.

SCHOOLS

AUTOMOBILE SCHOOL—Learn the automobile business, repairing and driving, in which you can earn good wages and have healthful and pleasant work. We give a thorough and practical course in road work and repairing. For full particulars address Academy of Automobile Engineering, 1420 Michigan Ave., Dept. "C," Chicago, Ill.

OPEN a Mirror Factory. We teach and trust you. 10c. brings booklet and particulars. None without $25 daily. Hullinger's Mirror School, Francesville, Ind.

CIVIL SERVICE EMPLOYEES are paid well for easy work; examinations of all kinds soon; booklet 50, describing positions and telling easiest and quickest way to secure them, is free. Write for it now. Washington Civil Service School, Washington, D. C.

INVENTIONS

EXPERT AND SUCCESSFUL inventor will develop ideas and inventions, build models, make drawings and give general advice in perfecting and marketing inventions. Long experience. Circular free. L. Casper, 633 No. Park Ave., Chicago, Ill.

INVENTORS. Perfector of inventions, experimental work, metal patterns, models, tools, punches and dies of all descriptions. Model shop, skilled labor, reasonable prices. Phone Main 4929. Mr. G. Schmidt, 168 S. Jefferson St., Chicago, Ill.

AGENTS WANTED

AGENTS—Our $2 adding machine is making a tremendous hit, good territory unoccupied. Smith Supply Co., B.-6, Los Angeles, Cal.

AGENTS—Handle a staple article, men's and women's handkerchiefs. Factory to consumer through you. Established line. Continuous orders. Rare opportunity. Write to Republic Mfg. Co., 2071 Greene St. ,New York.

EARN MORE MONEY! "The Booster Magazine" puts you "next" to a 600 per cent profit mail order business and an automatic press proposition actually paying workers $65 weekly. Other big features galore. In a class by itself. Get out into the sunshine. Quit "grinding!" "Booster" starts you. Two months' trial, 10 cents. P. M. Burdick, 351 Dearborn St., Chicago.

YOUR NAME ON RUBBER STAMP, 10c; with address, 15c; pad, 12c; dater, 15c. Stamps, 10c per line, postpaid. National Stamp Works, 110 Fifth Ave., Chicago. Agents wanted.

CLASSIFIED ADVERTISING
(CONTINUED)

AGENTS WANTED

STOP, women and men; hurry; seven new, useful fast sellers; 30 others to select from; big profits; write for $2 free offer and particulars. Fair Mfg. Co., Box 208, Racine, Wis.

DON'T ACCEPT an agency until you get my samples and particulars. Chance of a life time to get into a money-making business. T. M. Sayman, 2390 Franklin Ave., St. Louis, Mo.

AGENTS WANTED in every shop to sell our "Midget" knurled handle pocket screw-driver; sample, 10c. Sterling Novelty Co., Plainfield, N. J., Dept. E.

AGENTS—It's so easy to make $200 monthly with our Dash Board Line Holder. We are shipping them in 10 gross lots. Sample, prepaid, 30c. silver. Wholesale Supply Co., D 17, Valdosta, Ga.

THE LIGHTNING MULTIPLIER POST CARD will solve problems in multiplication quick as a flash, with absolute accuracy. Indispensable to every person who uses figures. Cannot get out of order. Send for one, and you will wonder how you ever got along without it. Agents wanted. Sample, 10 cents in stamps. The Simplicity Co., Chicago.

FOR SALE

FOR SALE—Complete set of castings, with blue prints of ¾ h. p. gasoline stationary engine; includes governor and timer, screws, etc., $10. Comet Motor Works, 17 W. Madison St., Chicago, Ill.

FOR SALE—Complete 3-rail electric railway. Cost $20.00. Will sell for $9.00. Further particulars for red stamp. E. A. Gordner, Box 547, Rochester, N. Y.

FOR SALE—Amateurs, make your coils with a slide wire bridge. Drawings and instructions, 50 cents. No toy. Cost, $3.00. Advance Bridge Co., 125 E. Jefferson St., So. Bend, Ind.

FOR SALE—A large quantity of No. 34 single silk magnet wire at $1.50 per pound; any address prepaid; nothing less than one-half pound. Geo. E. Glasser, Charlotte, N. Y.

EXCHANGE OR SELL your motors, generators, steam and gasoline engines, cameras, magic lanterns, phonographs, printing press, musical instruments, real estate or anything of value, new or second-hand. Send 4c stamp for best trading plan known. National Exchange Co., 929 Olive, St. Louis, Mo.

THREE THOUSAND FORMULAS—My 368-page volume of recipes and trade secrets, cloth bound, only 40c prepaid. Worth dollars. Satisfaction guaranteed. Wiley Sanderson, Dept. E, Ypsilanti, Mich.

SNOW SCENES—Views from one of Maine's most picturesque places. 5 ft. snow. 6 actual photo-cards, highly polished, 50c. Suitable for framing. C. Stanley, L. B. No. 5, Dixfield, Me.

FOR SALE

LUBRICANTS, asbestos, graphite and mica candles for loose pulleys and shaftings; no drip; no dirt; economical. Swain Lubricator Co., 252 E. Lake St., Chicago.

BUSINESS OPPORTUNITIES

CONCRETE—Learn how to handle this material, by reading "Concrete," a monthly magazine devoted to the uses of Portland cement. Practical, instructive articles, written in plain English. Sample copy, 10c. Yearly subscription, one dollar. Concrete Pub. Co., 299 Owen Bldg., Detroit Mich.

500 PER CENT PROFIT seems incredible, don't it? Send us 10c silver for copy of our folder, "How to Make Money Making Mirrors." Money returned if not satisfied. Economy Chemical Co., Box P-805, Ludington, Mich.

I HAVE listed with me to sell all subjects, I. C. S. and A. S. C. bound volumes. Do not buy until you get my prices. M. C. Suttle, McLeansboro, Ill.

SEND A DIME—coin or stamps—for a sample of "Just-Pull," the greatest electric light attachment on the market. A child can operate it. Easy money. No labor attached to the selling. Takes one minute to show it; can't get out of order; sells on sight for 25c. 100 percent profit. 2,000 sold to consumers at Chicago Electrical Show. Send ten cents for sample and full descriptive matter by return mail. Premier Novelty Company, Dept. C, 42 River St., Chicago.

MAKE MONEY AT HOME faster and easier than you ever dreamed possible. Russell's New Confection, Dairy Cream Crisp, sells like wildfire, from stores, on the street, or on trains. The more they eat the more they want. Profits, $5 to $10 a day, sure. Proceeds from a single batch pays for the formula, all raw material, and then some. A child can make it. Formula with full instructions, $1, postpaid to any address. Special: Until further notice, all orders will receive, free, my up-to-date method for making Stale-Proof Salted Peanuts; also my book, Straight Talk on Candy. Address Chas. E. Russell, 716 Clybourn St., Milwaukee, Wis. P. S.—Over 30 years a candy-maker.

1000 WAYS TO MAKE MONEY—This 125-page book, worth dollars, only 20c. prepaid. Satisfaction guaranteed. Landin & Co., Dept. 22, 97 E. Chicago Ave., Chicago, Ill.

WIRELESS

WIRELESS SUPPLIES—Norway iron core wire No. 22, straightened and cut to length, 20c. per pound. Core, 1x10 inch, weighs 1½ pounds. Wire for electrolytic detectors, 5c. per inch. No. 34 S. C. C. magnet wire, $1.23 per pound. All sizes and insulations at proportionate prices. Tin foil, 35c. per pound; 2000 square inch per pound. Leyden jars, 3¼x7, 60c. each; 1¾x4 for adj. cond., 40c. Catalogue ready in a few days. O. S. Dawson, 156 Wabash Ave., Chicago, Ill.

CARBON WIRELESS DETECTOR sent prepaid upon receipt of 50c. Simple, sensitive and strong. Dept. Q, 357 E. 46th St., Chicago.

CLASSIFIED ADVERTISING

(CONTINUED)

WIRELESS

LEARN WIRELESS TELEGRAPHY. Operators make big salaries. Why? Because they are scarce. Big field; easy to learn; cost small. Instructions free. H. B. Steele, 229 Greene Ave., Brooklyn, N. Y.

THE NEW SILICON DETECTOR will increase your receiving radius 500 per cent. Only type sold to experimenters authorized by owners of Silicon patents. Infringers prosecuted! Send for special price list. W. C. Getz, 345 N. Charles St. Baltimore, Md.

WIRELESS TELEGRAPHY—Send twenty-five cents, coin, today and receive by return mail complete instructions, with diagrams, for making a complete sending and receiving station. Among instruments described are 1-inch coil and two different types of receivers. Box 519, Lima, Ohio.

WIRELESS EXPERIMENTERS, 1200 OHM receivers, each $3.00. Wound with copper wire and very sensitive. First 25 sold will be fitted with nickel plated headband. W. C. Getz, 345 N. Charles St., Baltimore, Md.

WONDER MEDICAL COIL, 35 CENTS. No man can take full strength of it with one dry cell. Stamp for catalogue. Hertzian Elec. Co., 1924 Flatbush Ave., Brooklyn, N. Y.

1,000 OHM Wireless Receivers $1.75. Very sensitive and absolutely reliable. New Wireless Detector. You want to know about both. Send stamp for descriptive circulars. Alden Wireless Co., Campello, Mass.

WE HAVE THE HANDSOMEST, and clearest receiving ELECTROLYTIC DETECTOR in the United States. Price $1.50. Everything in Wireless. Stamp for catalogue. Hertzian Elec. Co., 1924 Flatbush Ave., Brooklyn, N. Y.

WIRELESS. One-inch spark coils, specially made for wireless. Fat hot spark. Regular $6.00. Special this month $4.50. Also larger coils. A B C Wireless Specialty Co., 111 Broadway, New York.

WIRELESS EXPERIMENTERS—The Wireless Equipment Co. has taken over the business of W. C. Getz and will continue the same high efficient apparatus. Address all communications to Wireless Equipment Co., West Arlington, Md.

STATIC MACHINES, $3.75, Wimshurst, 2-8-inch plates. 3-inch spark. Work in wet weather. Stamp for catalogue. The Hertzian Elec. Co., 1924 Flatbush Ave., Brooklyn, N. Y.

WIRELESS TELEGRAPHY. Complete instructions, with diagrams, for making 1 inch coil, two types of receiver, and all other instruments necessary for a complete wireless sending and receiving station. Price, 25 cts. (coin). Box 519, Lima, Ohio.

WIRELESS

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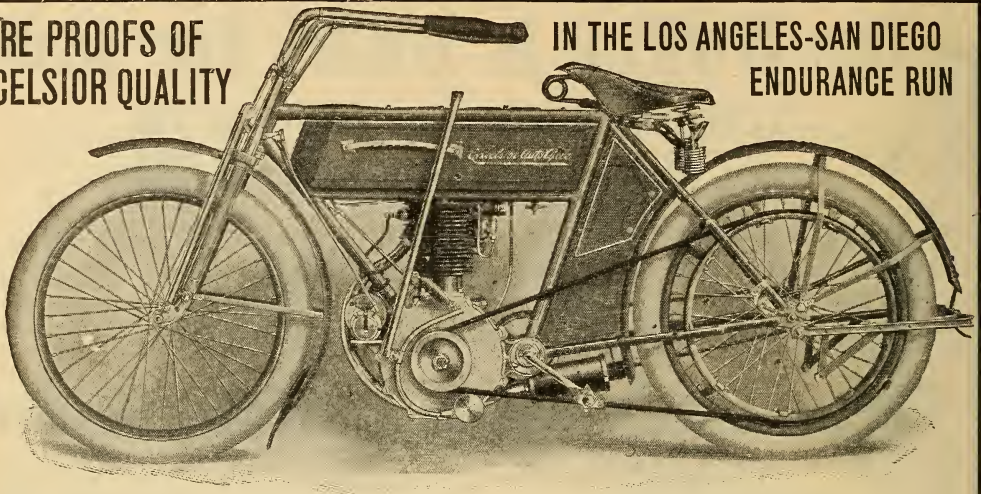

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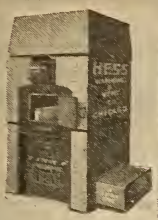

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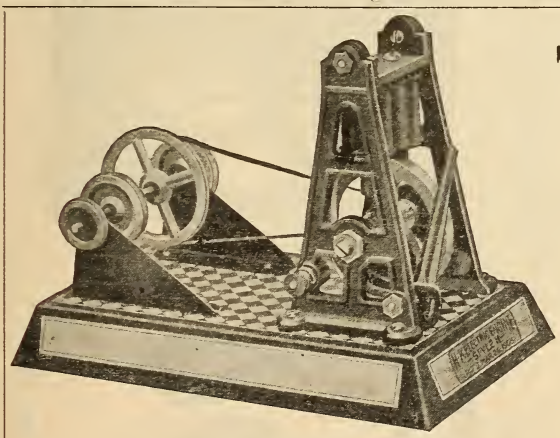

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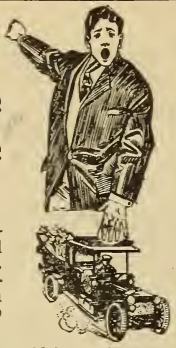

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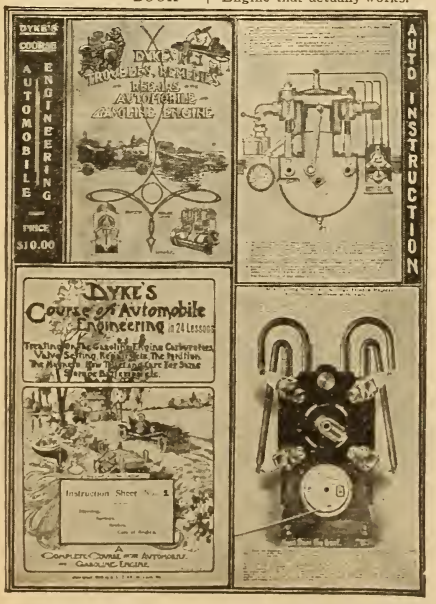
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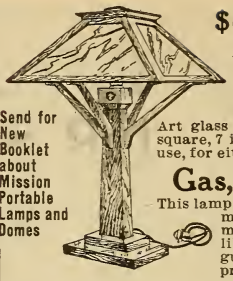

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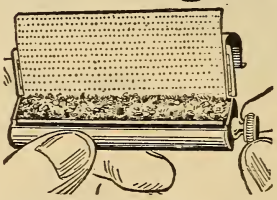

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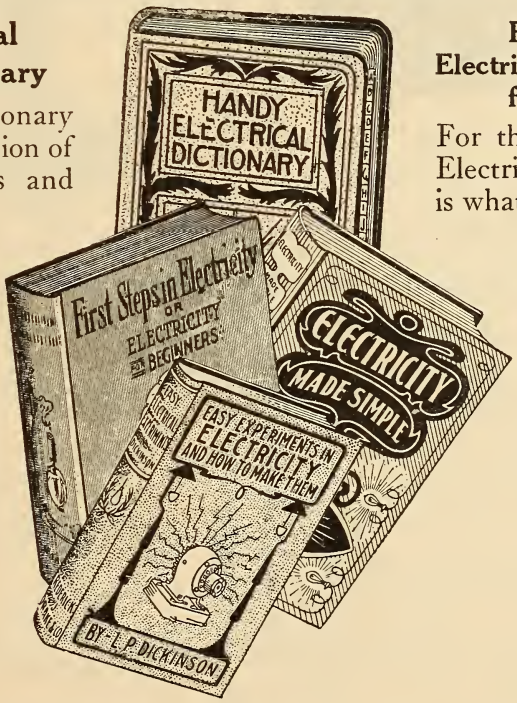
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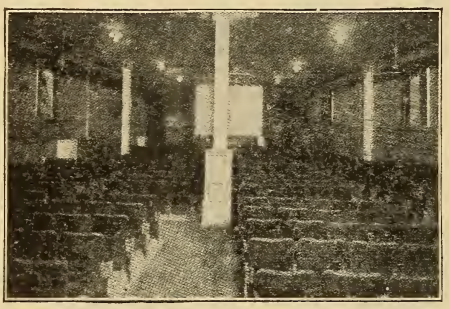

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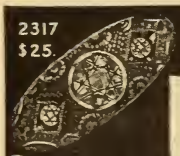

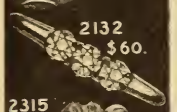

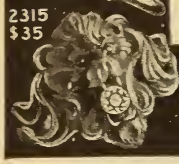

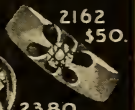

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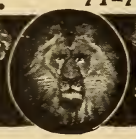

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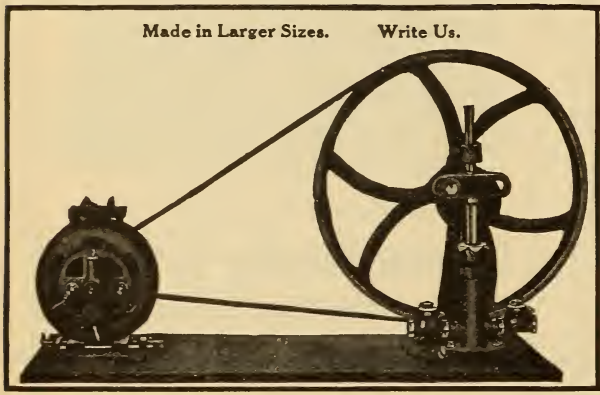

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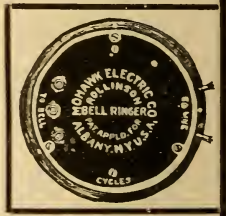

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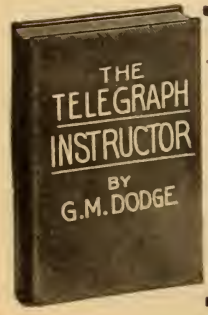

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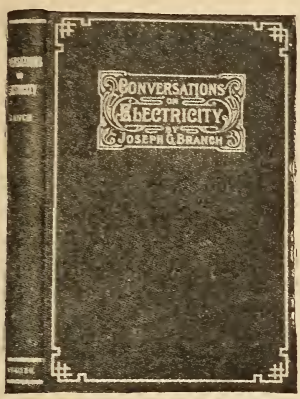

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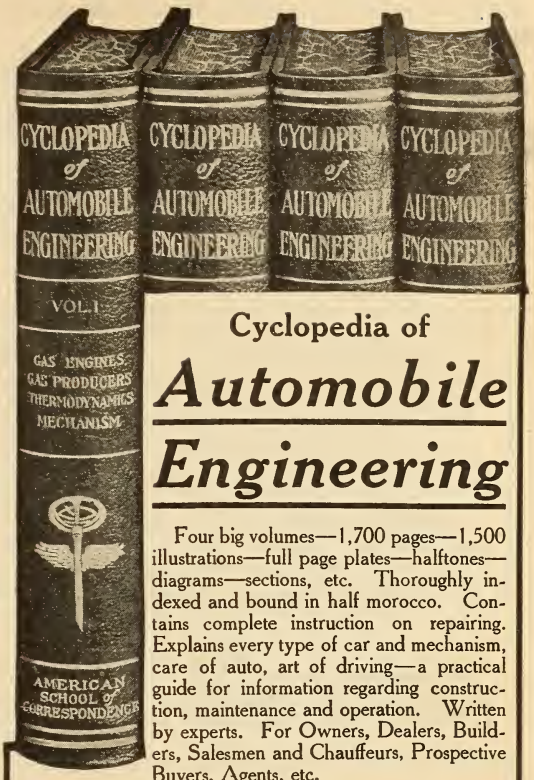

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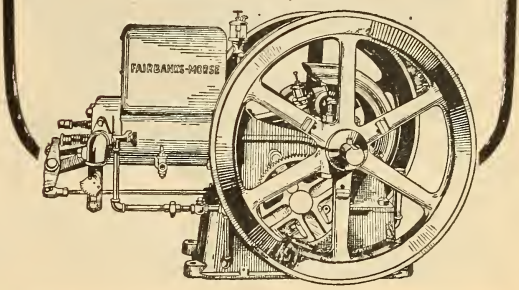

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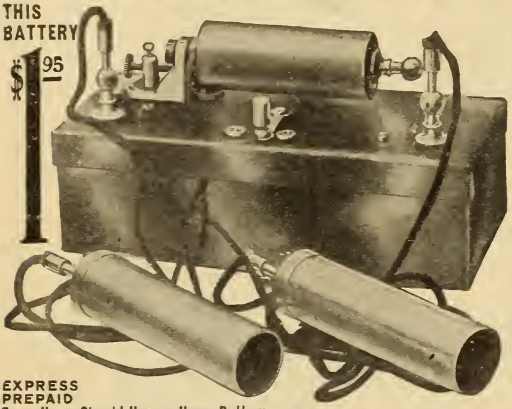

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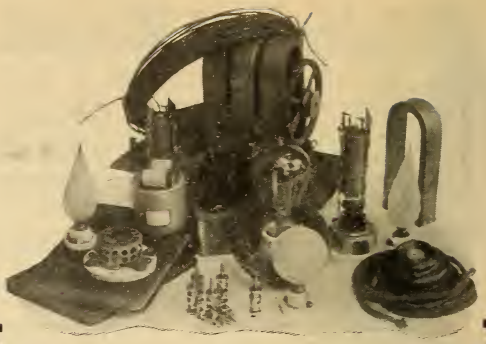

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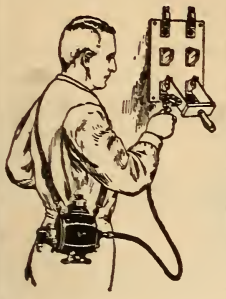

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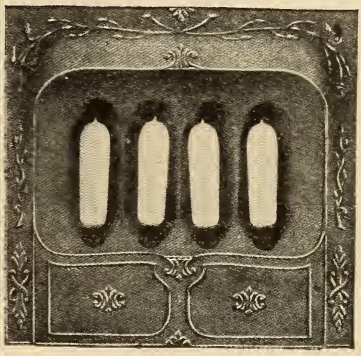

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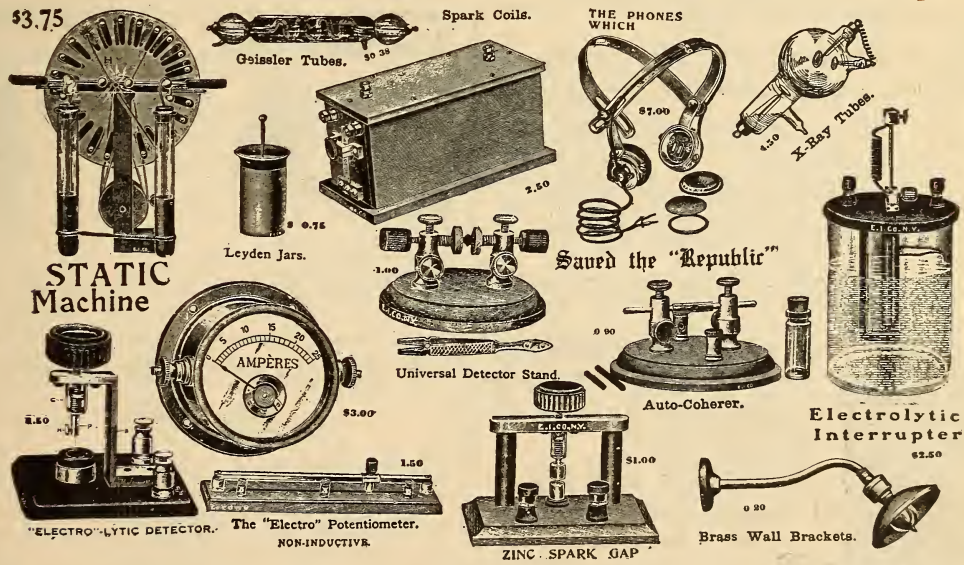

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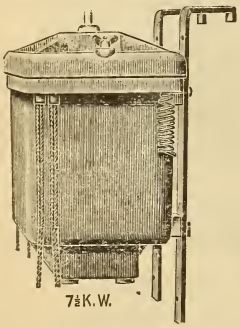

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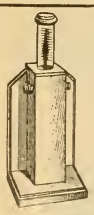

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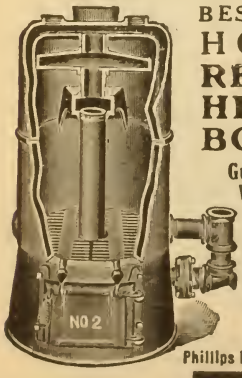

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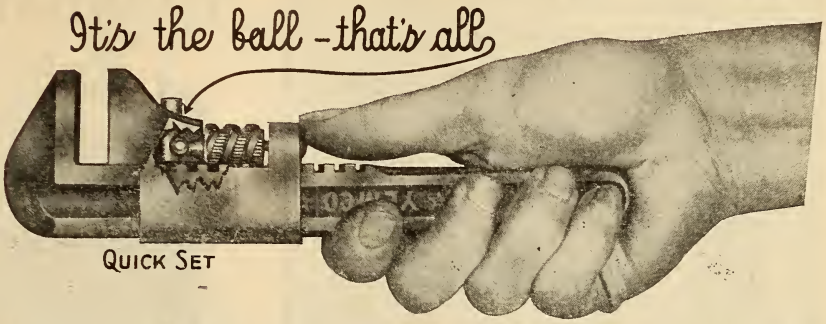

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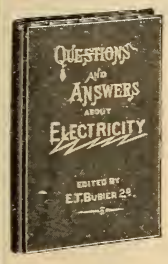

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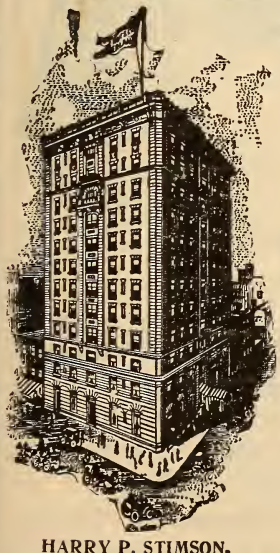

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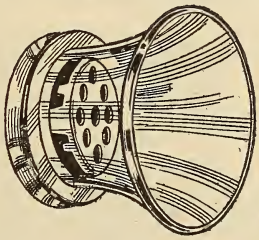

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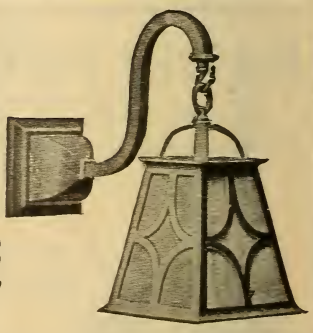

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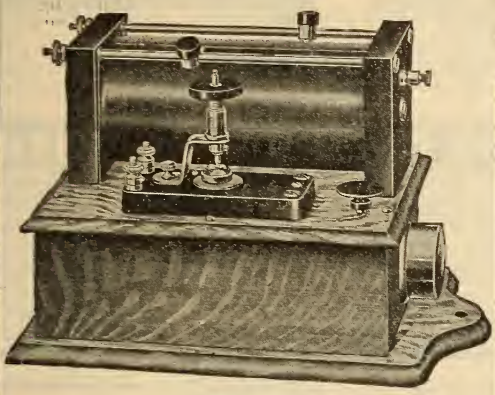

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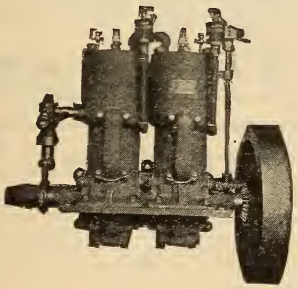

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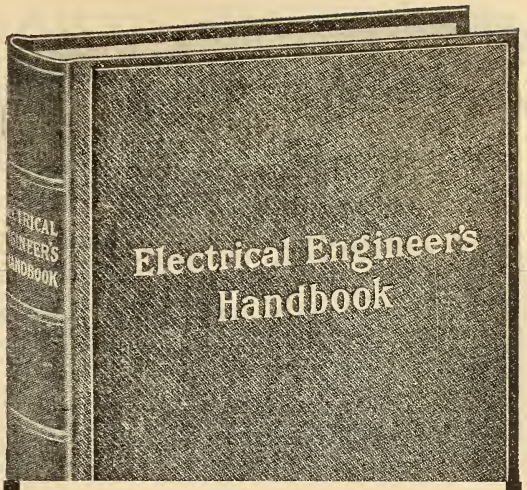

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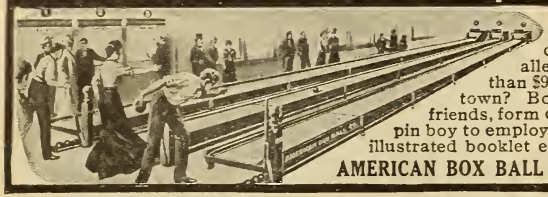

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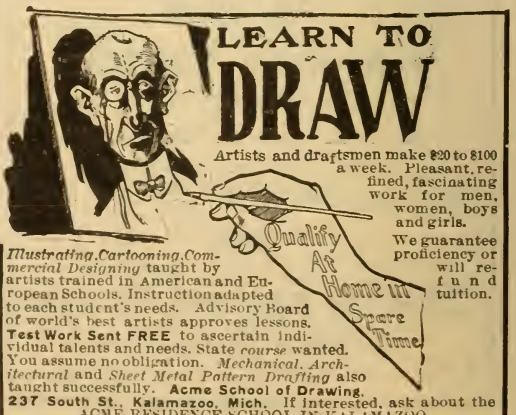
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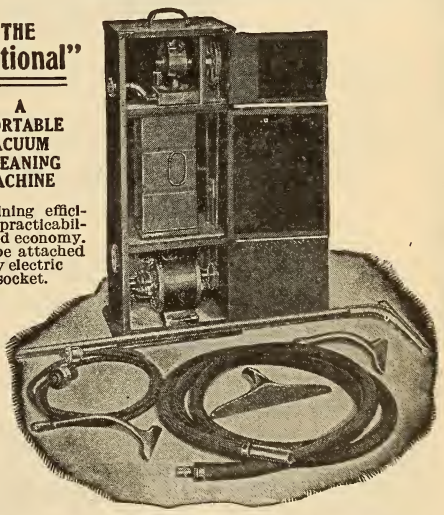

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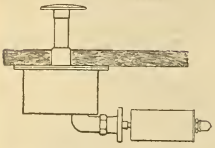

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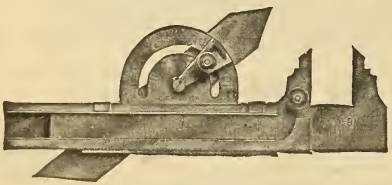

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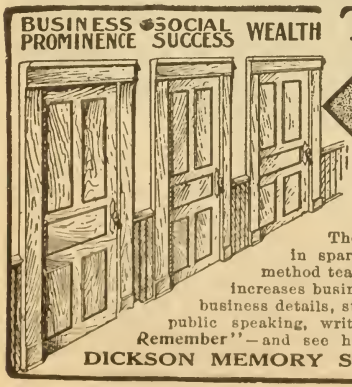

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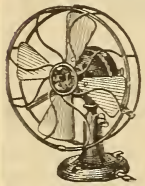

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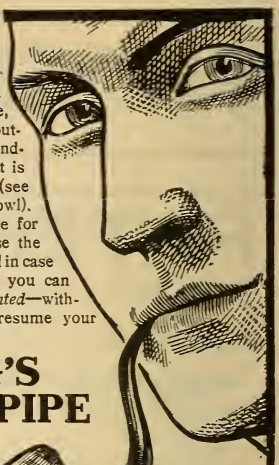

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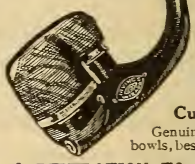

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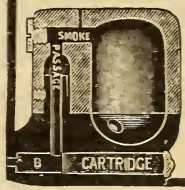

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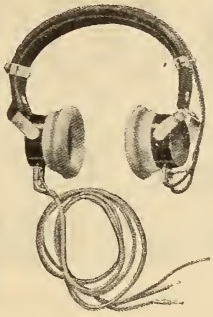

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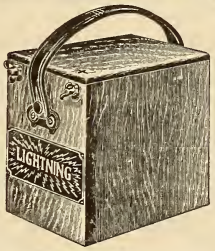

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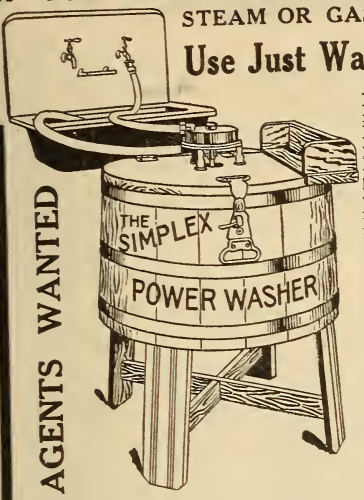

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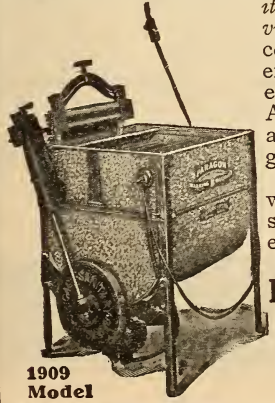

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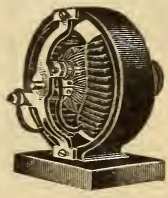

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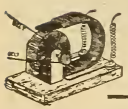

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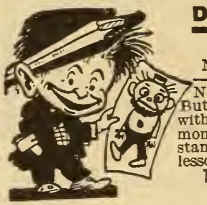

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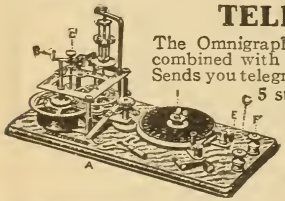

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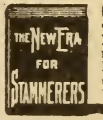

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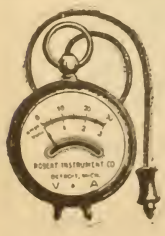

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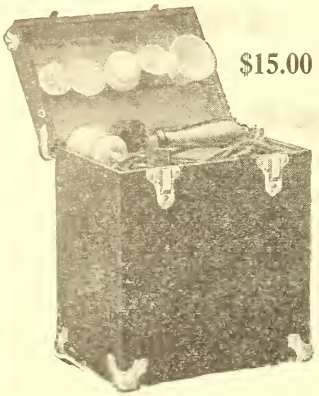

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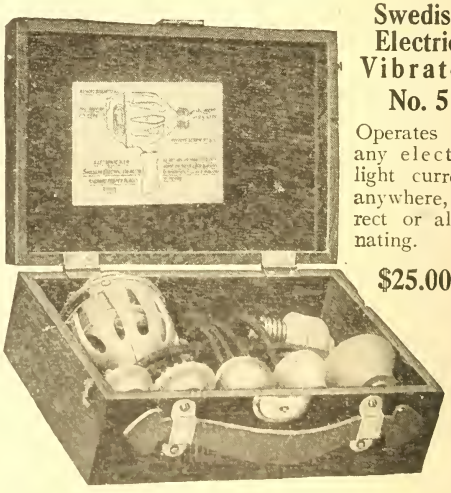

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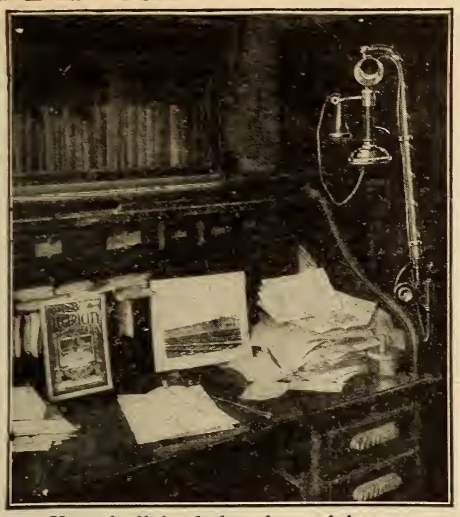

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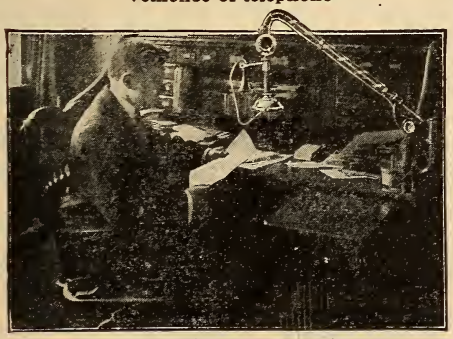

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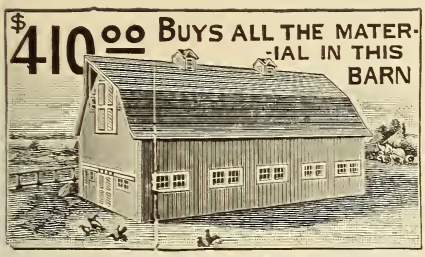

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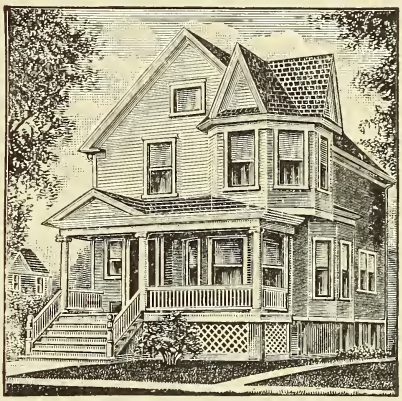

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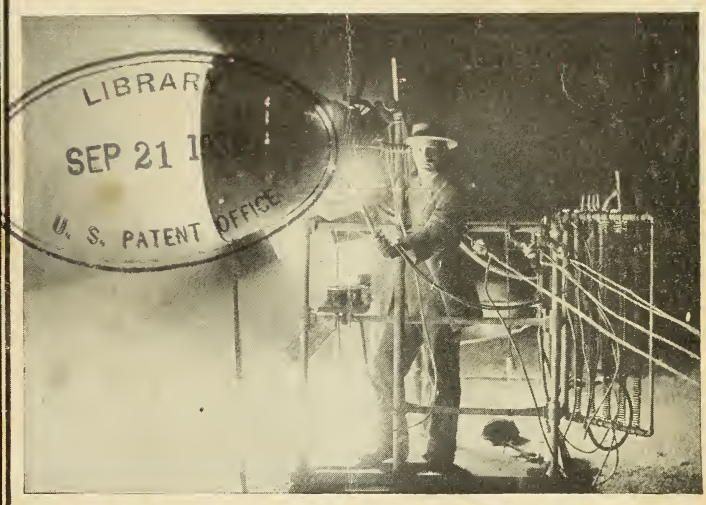

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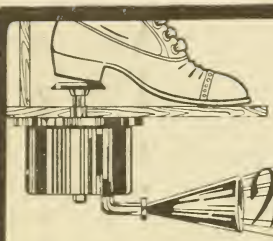

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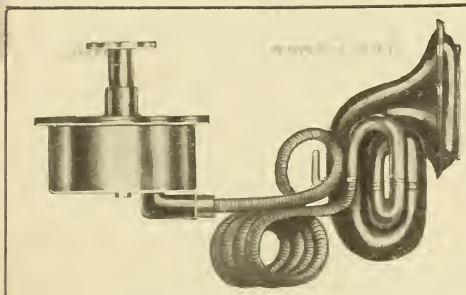

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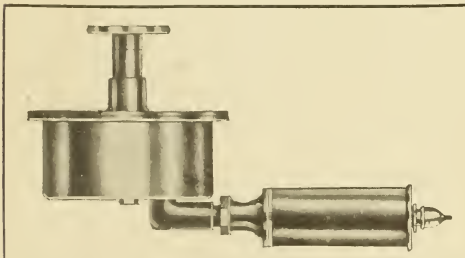

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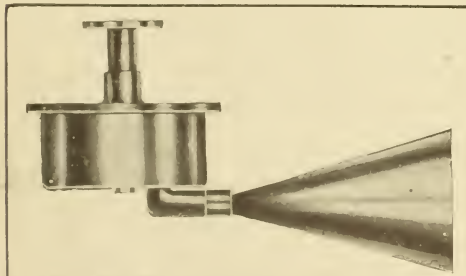

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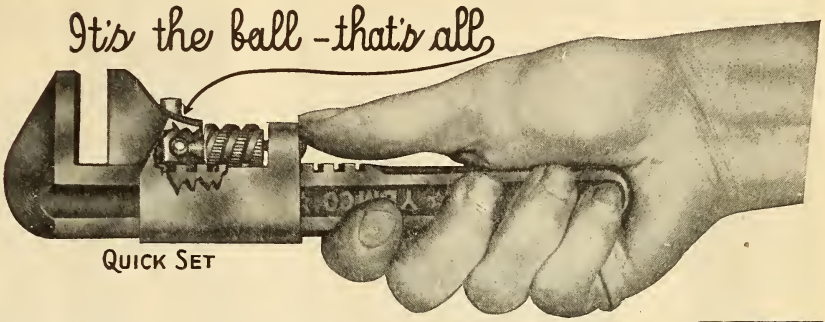

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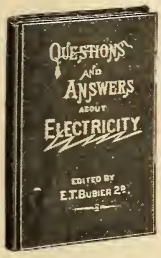

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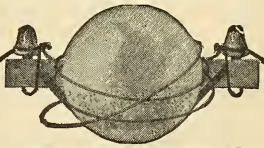

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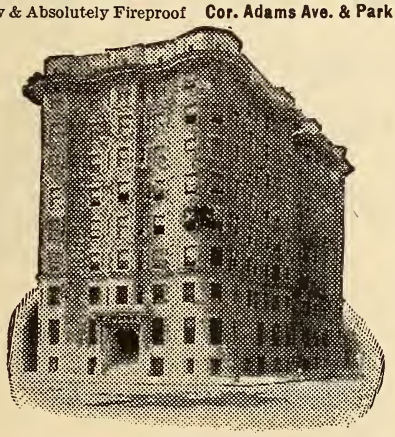

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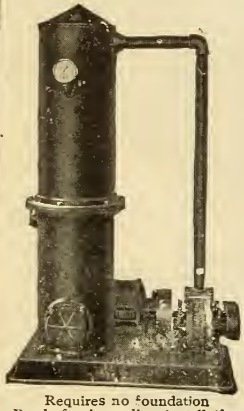

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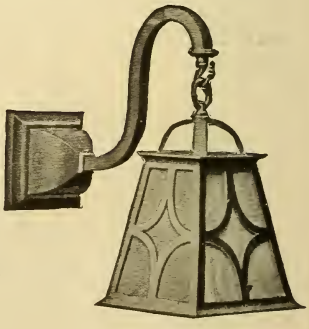

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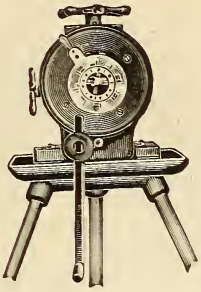

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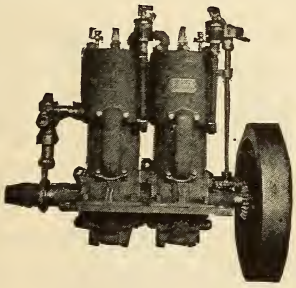

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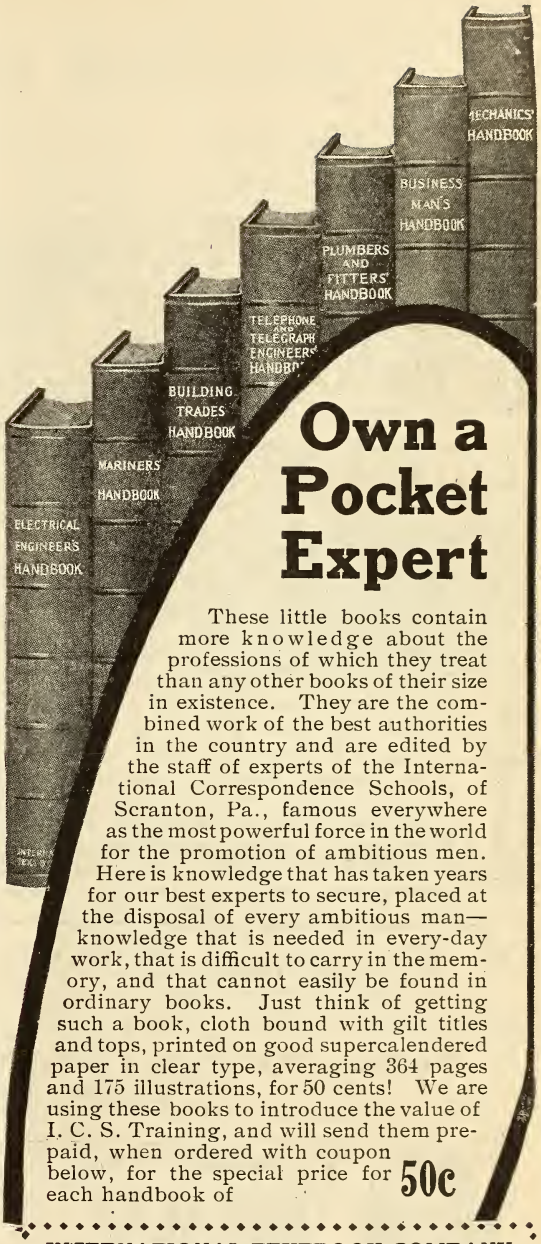

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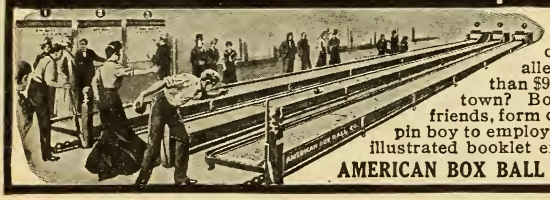

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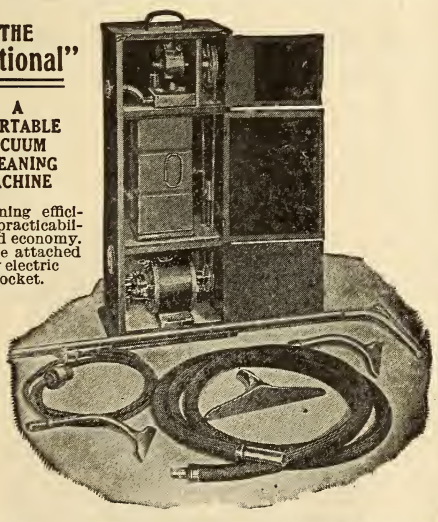

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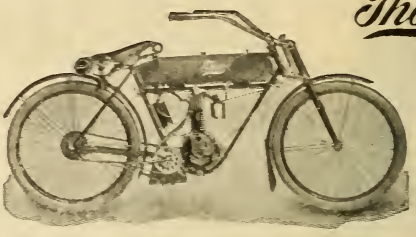

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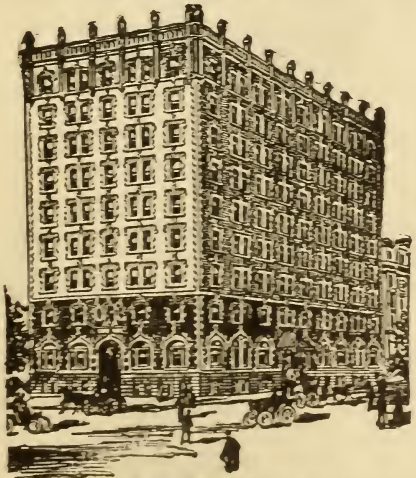

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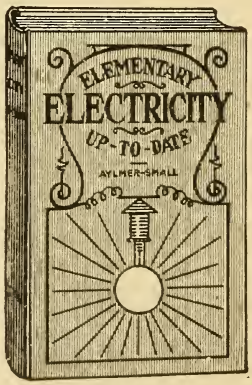

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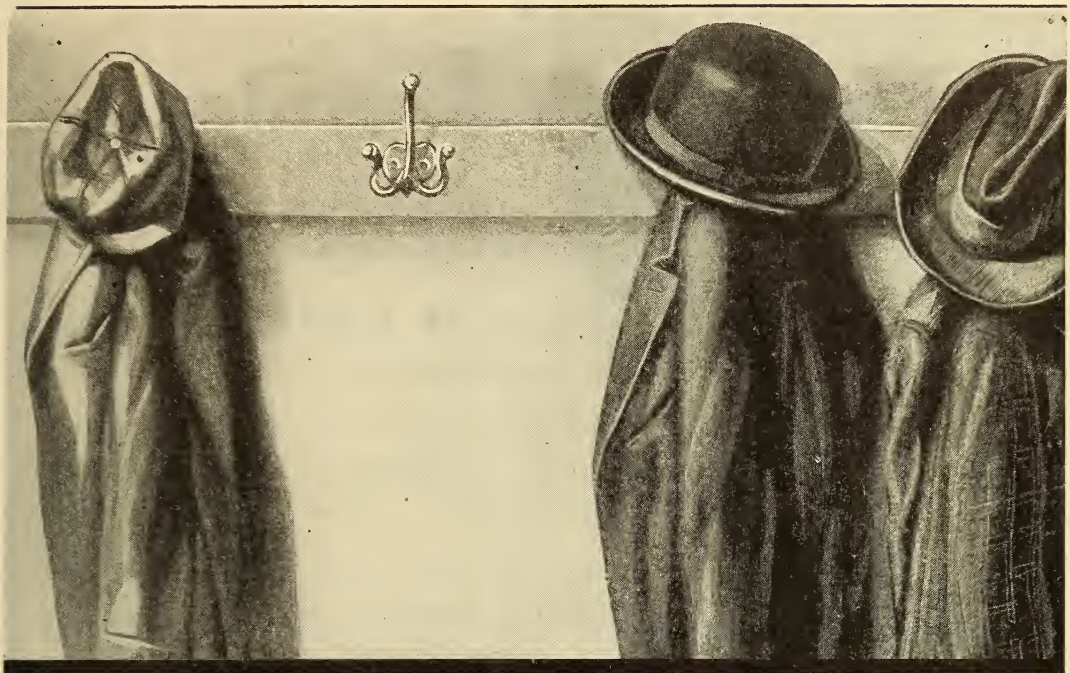

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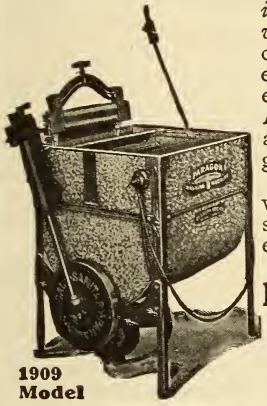

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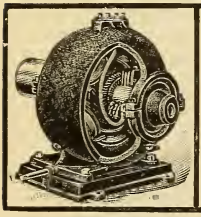

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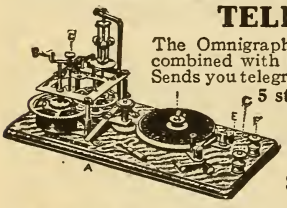

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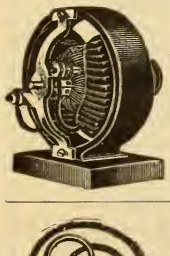

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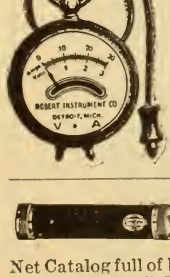

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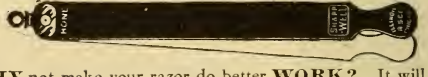

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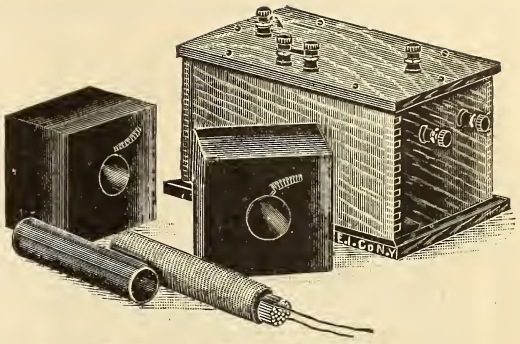

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Swedish Electric Vibrator No. 6

Operated by its own powerful electric batteries, equally as effective as the No. 5, but for the use of those not having access to the electric light current.

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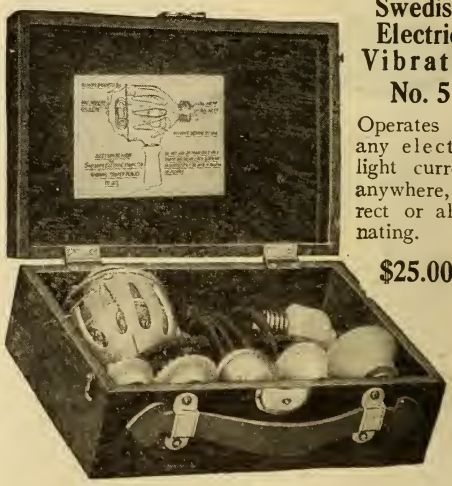

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Operates on any electric light current, anywhere, direct or alternating.

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Two 2 cent stamps bring our handsomely illustrated booklet, containing 22 half-tone pictures of well-known, prominent people and copies of letters they have written us together with charts, diagrams and instructions in PLAIN ENGLISH, showing WHY and telling HOW you can obtain new life, vitality and health without drugs, dope or diet.

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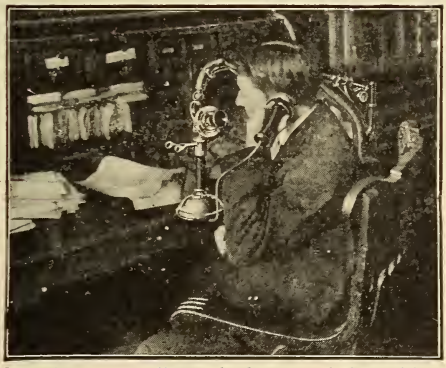
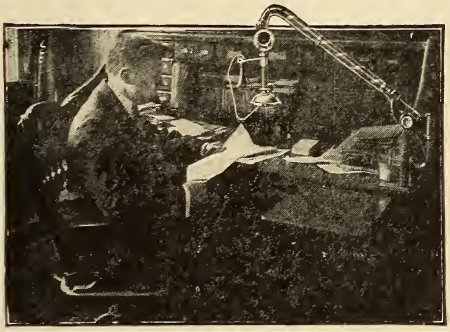
611 BERWIN AVE., - - - - CHICAGO, ILL.

Up and off the desk and out of the way when not in use



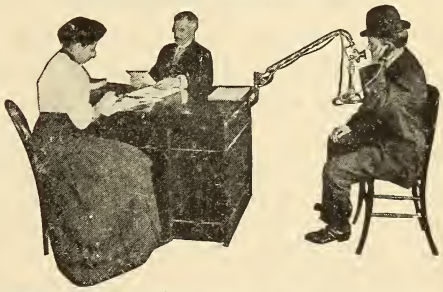
Permits one to adjust telephone to their position, not adjust self to position and convenience of telephone



Never in the way but always ready for instant service, sitting or standing

Your caller on the opposite side of desk can use the telephone without either of you getting up

If anyone wishes to use telephone while standing, you do not have to get up but simply push it up and over



Perfectly balanced; can be moved up or down, sideways or in a circle with the slightest touch and will remain in any position you put it

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The Radio is simplicity and perfection, has fewer parts than any other Telephone Holder, is better made and finished, meets with instant approval of all who see it. Fine enamel and oxidized copper finish. Agents wanted. Write for terms.

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CHICAGO

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FIRST: Subscriptions must be new ones; that is, for those not already subscribers. Renewals or extensions of present subscriptions will not do.

SECOND: Your own subscription can not be counted. All the subscriptions must be for others than yourself. In other words, we offer you these pens for **getting new** subscribers **for** us; **not** for subscribing **yourself.**

THIRD: Full remittance must accompany subscriptions, at the following Subscription Prices:

United States, Philippines, Porto Rico, Guam, Tutuila, Panama, Cuba, Mexico, and Shanghai, China ..... 1 year, $1.00
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This is the Most Liberal Proposition Ever Presented

A fountain pen is one of the greatest modern conveniences, and there are no better fountain pens made than the famous Parker "Lucky Curve" which we are offering. Every one is made from the best materials, finished in the most artistic manner by the highest grade of skilled labor, embodies the latest improvements, is fitted with the best grade of gold pen, and is fully warranted by the makers. A personal guarantee made out to the person securing the pen accompanies each one sent out.

You will be well repaid for the few minutes spent in securing a subscriber or two when you receive one of these handsome, valuable pens.

You'll find it easy to get subscribers because practically every one nowadays is interested in electricity, and POPULAR ELECTRICITY is the first and only ***real magazine*** to tell them all about this fascinating subject in language they can understand. Many of your friends and associates will gladly subscribe if you will simply show them a copy of the magazine and point out the many interesting features it contains.

We'll be glad to send you sample copies and circulars, on request, to help you, if you will mention this advertisement.

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Start right NOW—TODAY—and you'll have your pen before you know it.

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These Are the Genuine

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A very good pen—furnished in either black or mottled barrel. Fully warranted.

Given for one yearly and one six-month subscription or for one yearly subscription and 50c cash

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This is a better and a larger pen than No. 1. Can be furnished in black or mottled rubber or fancy chased barrel. Fully warranted.

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This is the same style, but larger throughout than No. 2. Supplied in either black or mottled rubber, and with fine, medium, coarse or stub pen as wanted. One of the most popular styles on the market. Fully warranted.

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This is a new style. Similar to above, but has beautifully chased barrel and cap. Particularly suitable for lady's pen, and can be furnished in smaller size if desired. Fully warranted.

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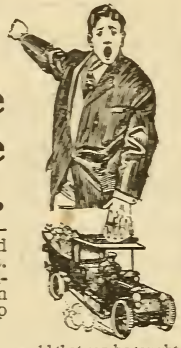
....with....

Dyke's Course of Automobile Instruction .....



STUDY during spare time—Dyke's Course is now only $10 and you would never miss the amount. The Automobile and Gasoline Engine profession is the best profession and there is a big demand for help in this line.

DYKE'S COURSE is the only course in the world that can be taught successfully by mail. We use wonderfully clever **working models** of the Gasoline Engine and Magneto that actually work and they picture the meaning while you study our interesting Instruction Pamphlets. You will play with these models like a boy with a toy and the more you play the clearer the subject will be to you.

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WE TEACH YOU everything there is to learn about the Automobile and Gasoline Engine such as valve setting, turning ignition, how the cylinders fire, construction of all forms of Magnetos and how to set them, storage batteries and all systems of wiring, and many other important subjects.

ONE CUSTOMER SAYS:

"I've learned more in three weeks study of your Course than during my ten years work around the shop."

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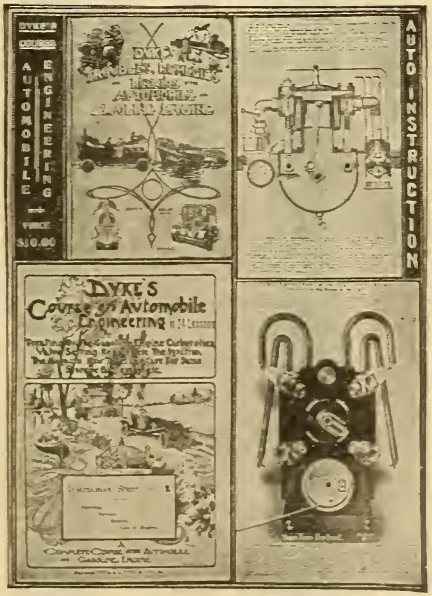

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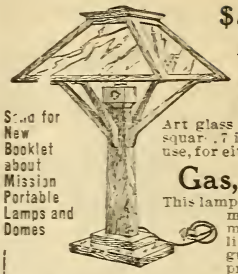

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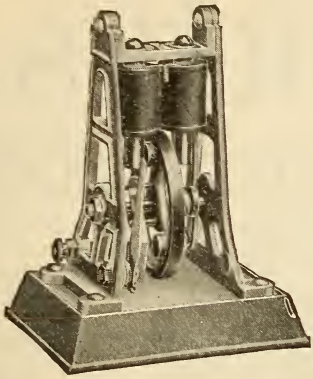

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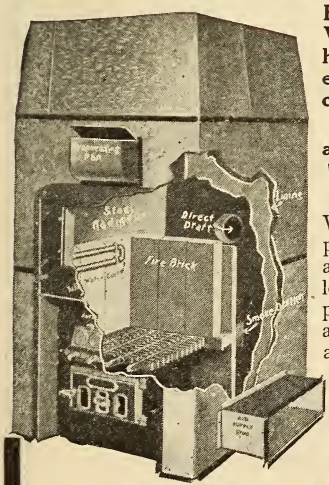

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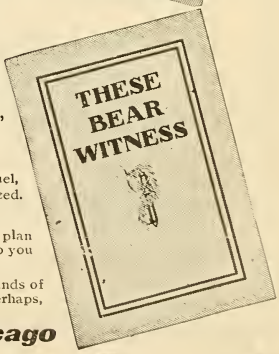

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(And this is addressed to the gentleman who is now reading it.)

A man who is an acknowledged authority in the cigar business, recently said to a friend of mine: *"Shiver's Panetela Cigar is a good cigar—better than I expected, and for the life of me I don't see how it can be sold for the money."*

I will tell him, as there are no secrets in my business.

Re-orders—My cigars have to sell themselves. They are good enough to cause men, in constantly increasing numbers, to re-order them on their own volition, and they do.

As an instance: One firm in New York has bought from me during the past five years an average of over *one thousand cigars per month* for their own and their employees' smoking. The office of this firm, by the way, is within three minutes' walk of three of the best retail cigar stores in the world

If I had to hunt up a new customer every time I make a sale it would put me out of business in a month, but re-orders, not once, but repeatedly, I must have and do receive in continually growing volume.

The result is I have built up a constantly increasing patronage. Incidentally I have sufficient standing orders for cigars, to be shipped on stated days of the month as they come around, to keep a small factory busy.

Every cigar that I make is sold direct to the consumer in lots of a hundred or more at wholesale prices (there are no discounts to dealers or clubs, nor for any quantity), and is shipped from the factory in the best of condition without any rehandling.

I manufacture every cigar that I sell, consequently *know* exactly what is in them.

In do not retail cigars nor sell sample lots. It costs more to do so than to ship the original package, and in addition, one or two cigars is not a real test. Moreover, I might be charged with sending samples better than the goods prove to be. I ask smokers to give the actual cigars a fair trial, and if they are not pleased, to return the remainder. I cannot afford to have any one displeased.

My theory at the start was that most men know and appreciate cigar values, and that they would sufficiently appreciate the difference between retail and wholesale cigar prices to go to the trouble of ordering cigars from me could I once induce them to give the cigars a fair trial. To get them tried—to get *you* to try them—is why I make my offer so broad and so liberal. What risk can *you* assume, provided, of course, that $5.00 per hundred is not more than you care to pay?

My factory is close to the business center of the third largest city in the United States. It is open to my customers and friends.

My Offer is: I will, upon request, send one hundred Shivers' Panetela cigars on approval to a reader of POPULAR ELECTRICITY, express prepaid. He may smoke ten cigars and return the remaining ninety at my expense, and no charge for the ten smoked, if he is not pleased with them; if he is pleased, and keeps them, he agrees to remit the price, $5.00, within ten days.

SHIVERS' PANETELA EXACT SIZE AND SHAPE

In ordering, please use business letter-head or enclose business card, and state whether mild, medium or strong cigars are desired. Write me if you smoke.

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VACATION MONEY

DO you want to earn some spending money during these summer months? We have an article which fills a long-felt household want. It sells readily to anyone who uses electricity. The

DIM-A-LITE

is a device for turning down electric lights, making possible a high, low or medium light as desired. You can sell quantities of them because of the fact that they actually reduce the amount of current consumed from 20 to 70 per cent

Your friends and neighbors will be glad of the chance to cut down their light bill.

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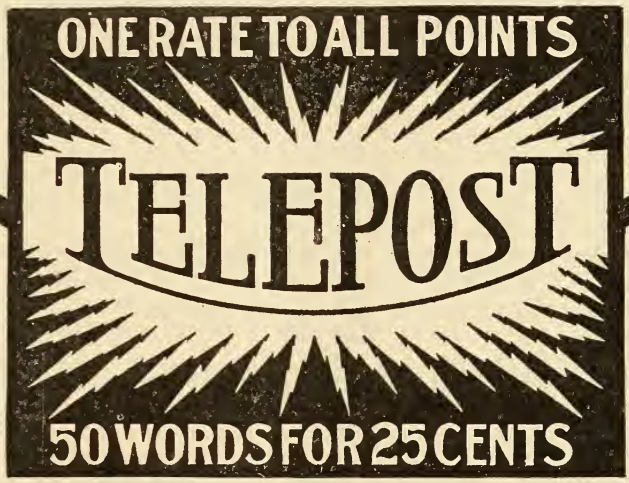

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¶ An interesting illustrated booklet has been prepared, describing in detail the invention, its operation, its economy, its rapidity and its accuracy. Mailed without cost to any one asking for Booklet No. 381.

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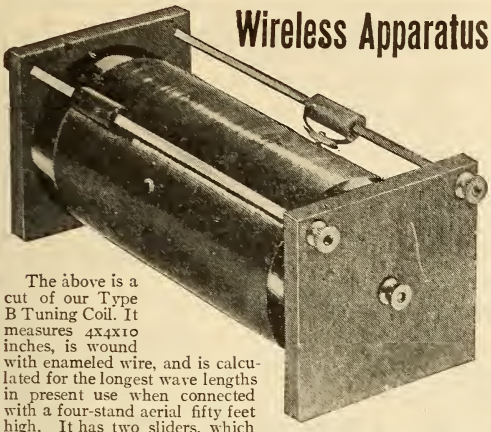

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(A long coil with very high inductance)

Send for prices on anything you may require. See our advertisement in the July number.

Look for a surprise in September.

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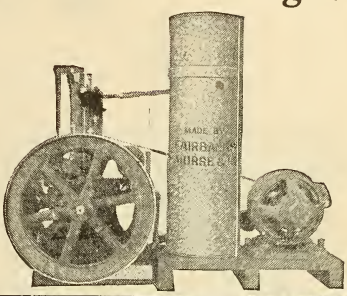

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Write for our Catalog telling you all about it

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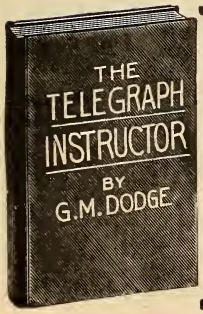

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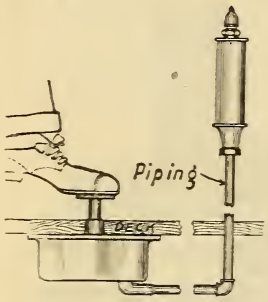

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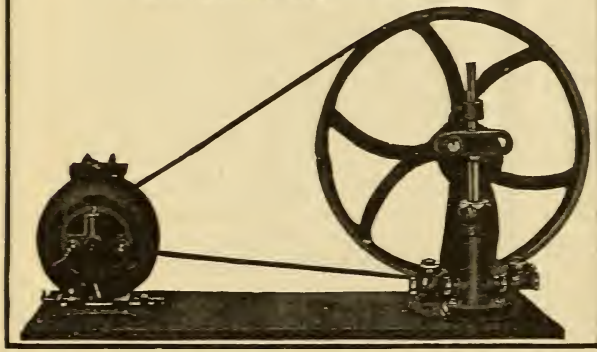

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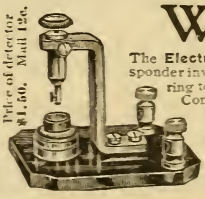

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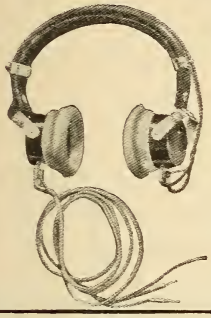

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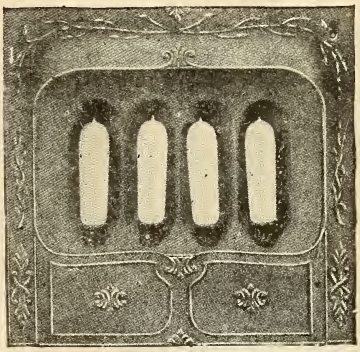

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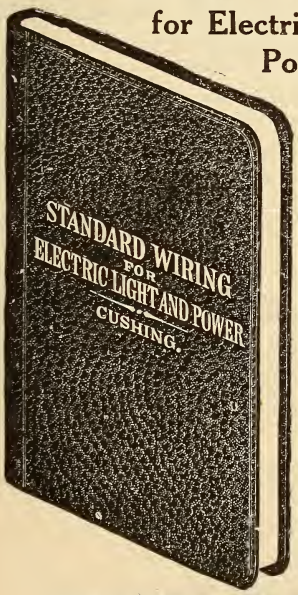

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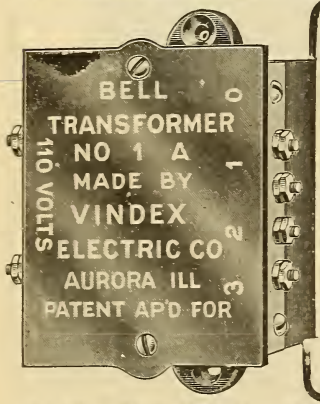

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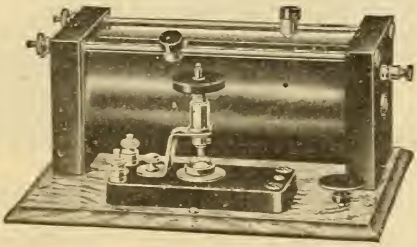

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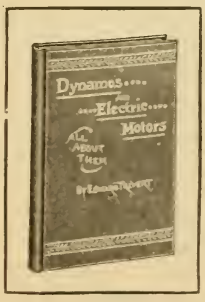

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POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. II AUGUST 1909 No. 4

GEORGE SIMON OHM

The man who by independent discovery and announcement of a law in Nature's observed operations laid one of the foundation stones of modern electrical science and achievement

What is Ohm's law? Why is the unit of electrical resistance called the Ohm? These questions are best answered by a brief sketch of the career and work of George Simon Ohm, who lived more than a century ago, and for whom the law and the unit were named.

Ohm's law is known to everyone who makes the application of electricity a study. The discovery and announcement of this law by Ohm brought order and understanding where confusion had before reigned, for it is this simple law which governs all the operations of direct current electricity.

This law observed by Ohm is that the intensity of the current (measured in amperes) is directly proportional to the exciting force (measured in volts) and inversely proportional to the total resistance (measured in ohms). Stated another way: Current equals electromotive force divided by resistance; or, as we most often see it written $C=\frac{E}{R}$. Knowing any two of these factors we are able to find the third by solving the equation.

The unit of resistance to the flow of electricity was also named after Ohm and is defined as the resistance offered to an unvarying current of electricity by a column of mercury, at the temperature of melting ice, having a height of 106.3 centimeters, a uniform cross-sectional area and a weight of 14.452 grams.

Ohm was born at Erlangen, Germany, in 1789. His father was a humble locksmith, athirst for knowledge. An able mathematician himself, he taught his son mathematics, and trained the boy in the locksmith's trade.

Young Ohm grew up in the love of his electrical research work, and the treatise in which he first announced his great discovery, entitled "The Galvanic Battery Treated Mathematically," has become a famous classic of science. This was published at Berlin in 1827.

An independent discovery of the law governing electrical current flow was made by Cavendish in 1781, but it was not publicly recognized until the work of Ohm was done. Ohm obtained his results chiefly by experiment.

In 1841, the Royal Society of England honored him with the Gold Medal for the "most conspicuous discovery in the domain of exact investigation."

He died of epilepsy on July 6th, 1854, at the age of 65. His Spirit, devoted on earth to the search for Truth, still lives as a power in the great Cause World.

ELEMENTARY ELECTRICITY

BY PROF. EDWIN J. HOUSTON, PH. D. (PRINCETON).

CHAPTER XVI.—FRICTIONAL AND ELECTRO-STATIC ELECTRIC MACHINES.

There are various forms of electric machines that depend for their operation on friction. Before being able to understand them, however, it is necessary that an explanation be made as to the manner in which electricity can be produced by what is called induction.

Perhaps the simplest definition of electrostatic induction is the influence produced by an electric charge on a neighboring body through an intervening non-conductor. Suppose, for example, that the insulated metallic sphere (C), Fig. 102, is given a positive electric charge, and is then brought near an

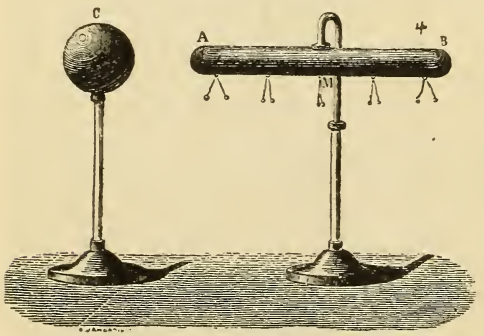


FIG. 102. ELECTRIFICATION BY INFLUENCE

insulated metallic cylinder (AB), provided with a number of pith ball electroscopes. Although the two cylinders are separated by a fairly considerable mass of air, a non-conducting substance, the charge on (C) produces an electric charge on (AB), as is shown by the repulsion of the pith balls. The amount of this repulsion is greatest both at the end (A), nearest (C) and at (B) furthest from (C), the divergence becoming less as we pass from either end towards the middle of the cylinder.

The electrification thus produced by an electric charge in a neighboring body through an intervening non-conductor is known as electro-static induction. In order to distinguish this induction from that produced by a magnet, it is sometimes called influence. The term electrostatic induction, however, is more frequently employed.

It can be shown that the charges produced in the cylinder (AB) consist of opposite electricities. If the sphere (C) is charged with positive electricity, then the charge at the end (A), nearest (C), is negative, while that at the end (B), furthest from (C), is positive. The character of these charges can be determined by bringing a rod of sealing wax, rubbed so as to become negatively excited, into the neighborhood of the pith balls at (A). The fact that these are further repelled shows that their charge is negative, or the same as the charge on the sealing wax. If, however, the sealing wax is brought into the neighborhood of the balls at (B) they are attracted, thus showing that they contain a positive charge.

What takes place in the above experiment is as follows: According to the single-fluid hypothesis, which we shall use on account of its greater simplicity, the free positive charge on the insulated cylinder repels the electric fluid in (AB) to the end furthest from (C), thus giving that end a surplus of electricity and rendering it positive, at the same time leaving a definite amount of electricity at the end nearest (A), thus making it negative.

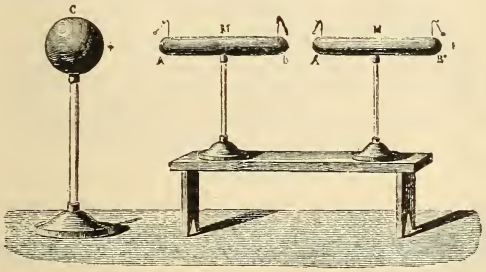
If the cylinder (AB) is slowly moved away from (C), care being taken not to touch it, the pith balls will show a smaller and smaller divergence until, when a certain distance is reached, varying with the value of the charge in (C), they will come together showing that the cylinder has completely lost its induced charge.

If, however, while under the influence of (C) the cylinder is momentarily touched, say near the end (B), by a body connected with the earth, as by a person standing near it, then, on its removal from the neighborhood of (C), it will be found to possess a permanent electric charge which is negative over all parts of its surface.

It is not difficult to see why a body can only be permanently electrified by induction when momentarily touched by an earth-connected body. When the cylinder (AB) is touched, the repulsion produced by the positive charge on (C) drives the positive electricity to the ground. The negative charge near the end of (A) however, remains on the cylinder, being held in place by the attraction of the opposite charge on (C).

When (AB) is removed from the influence of (C) its charge, being no longer held in place, is free to distribute itself evenly over the entire surface.

It is evident that charges produced by induction must always consist of the two opposite electricities; that these charges will manifest their presence only while the charged body remains in the neighborhood or influence of the electrified body. If, however, during this time the charged body be momentarily connected with the earth, it will lose a charge of the same name as the inducing body and become permanently charged by a charge of opposite name.



103. ELECTRIFYING A SERIES OF CONDUCTORS BY INFLUENCE

It is possible to produce successive electrifications by induction. If, for example, two insulated metallic cylinders (M) Fig. 103, be brought as shown in the neighborhood of a positively charged insulated sphere (C), then alternate negative and positive charges will be produced by induction on the ends of (M) and (M) as marked, negative charges being found on the ends (A) (A′), situated nearest (C), and positive charges on the ends (B) (B′), furthest from (C), the presence of these charges being manifested by the movements of the pith balls as shown.

It is evident, from the above, that an electric charge may exist on the surface of an insulated body in two different ways; namely, in what is known as a free charge, and in what is known as a bound charge. A free charge is immediately lost by an insulated body when touched to an earth-connected body. The bound charge, however, remains on the insulated body, notwithstanding the fact of its being connected with the earth, since it is held in place by the attraction of an opposite charge.

We are now able to understand why an electric charge produces alternate attractions and repulsions in unelectrified bodies brought near it. Electric attraction is invariably preceded by electrostatic induction. Suppose, for example, Fig. 104, (C) is an insulated body containing a positive charge, and that (ab) is a movable body suspended by an insulating thread. On the approach of (C), induction occurs in the movable body, a negative charge being produced on the side nearest (C) at (a) and a positive charge on (b), the side furthest from (C). Under the influence of the opposite charges the movable ball is drawn towards (C). It there has its negative charge neutralized, and becomes charged with the same kind of electricity that exists in (C), i. e., positive electricity, is now repelled.

If the movable body has no means for losing its positive charge, it will remain repelled for a long while. If, however, it is able by repulsion momentarily to touch an earth-connected body, it loses its charge, again receives opposite charges by induction, and is again attracted or repelled, the alternate motions being kept up as long as a charge remains in (C).

The non-conducting medium existing between the charged body and the body in which electro-static induction takes place is known as a dielectric. All non-conductors of electricity are capable of acting as dielectrics. They differ, however, considerably

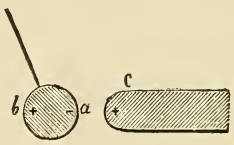


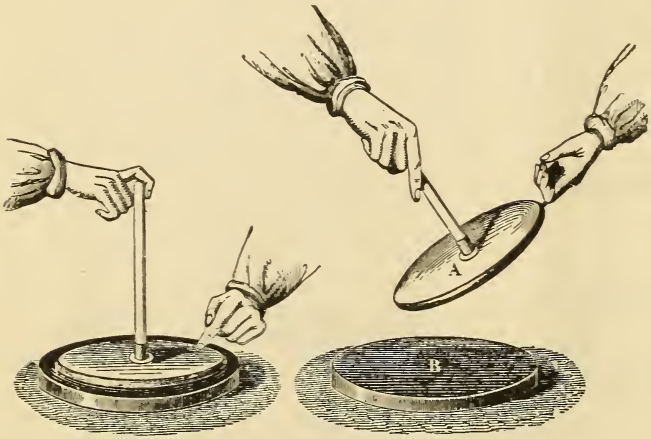
FIG. 104. ILLUSTRATING ELECTRO-STATIC INDUCTION

in their power of thus permitting induction to take place through them. For example, if a plate of thick glass is placed between the insulated sphere (C) and the end (A) of the insulated cylinder, the induction will not only take place through the glass, but will take place more freely as will be indicated by the greater repulsion of the pith balls.

In the following table the dielectric capacity, or specific inductive capacity of different non-conductors are given, or the ability to permit electrostatic induction to take place through them. In this table the dielectric capacities of the different substances are compared with air taken as unity.

Air	1.00
Solid Paraffine	1.99
India-rubber	2.22
Vulcanite	2.28
Gutta Percha	2.46
Sulphur	2.58
Shellac	2.74
Glass	3.25

The first, if not the simplest form of electric machine for producing electricity by friction was an instrument invented by Volta and known as the electrophorus. This device consists, as shown in Figs. 105 and 106, of a cake of resin (B) about twelve inches in diameter and an inch in thickness, placed in a metallic dish. The simplest way to form this cake is to melt equal parts of ordinary resin and shellac in a metal plate. When thoroughly fused and mixed together remove the pan from the source of heat, placing it on a flat support and taking care before the liquid hardens to break up any air bubbles that may form. When hardened there will be produced a smooth surface of resin filling the metal pan.



FIGS. 105 AND 106. THE ELECTROPHORUS

The remaining part of the electrophorus consists of a metallic disk (A), smaller in diameter than the resin disk (B), provided with an insulated glass handle, so that it can be moved without touching its metallic surface.

The electrophorus is operated as follows: The disk of resin (B) is given a negative charge by rubbing it briskly with a piece of cat's skin. The metallic disk (A) is then placed in the middle of (B) and momentarily touched by a finger. It immediately parts with a negative charge, so that when removed from the resin, it will

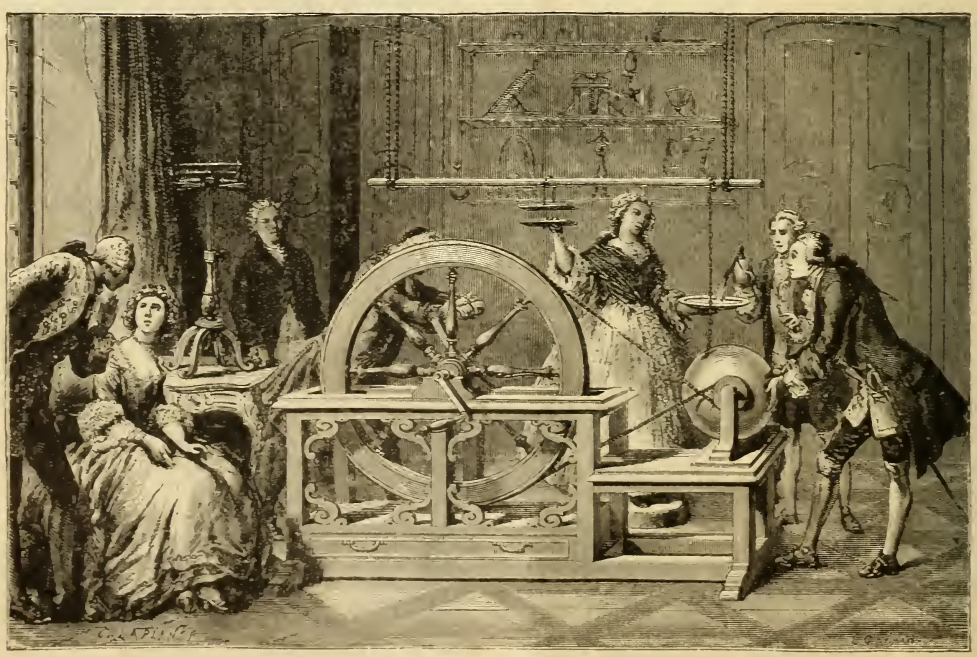


FIG. 107. HAWKSBEE'S FRICTIONAL ELECTRIC MACHINE

possess a positive charge, and if, while being held in one hand by the glass rod, it is held near the knuckle of the other hand, a bright spark accompanied by a crackling sound will be produced.

The explanation is evident. When the metallic disk is placed on the negatively charged resin surface, a positive charge is produced on its surface near the resin disk;

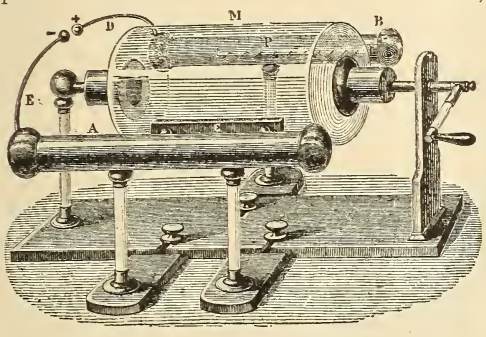


FIG. 108. EARLY METALLIC COMB MACHINE

and a negative charge on the surface furthest from it. While momentarily touched, it loses this negative charge and, therefore, remains positively excited after its removal from the resin.

Electricity produced by means of friction was originally obtained by rubbing glass rods with silk handkerchiefs. The first frictional electric machine was devised by Guericke, the inventor of the air-pump. This machine consisted of a ball of sulphur, the friction being produced by the hands of an assistant held against the ball while rotated. Fig. 107 represents Hawkesbee's modification of Guericke's electric machine in which the ball of sulphur is replaced by a hollow globe of glass. The construction and operation of the machine will be understood from an examination of the above figure, as will also the means employed for carrying, by a metallic chain, the charge so produced on the glass to a conductor consisting of a metallic rod suspended from silk cords attached to the ceiling of the room. In the figure a woman is seen standing on an insulating cake of resin holding one hand near the insulated rod and in the other a metallic disk that receives the electricity through her body. The rotation of the sphere by means of a cord passed over the wheel and pulley is also shown.

The simple electric machines of Guericke and Hawkesbee were greatly improved by two additional devices. The first consisted of a leather cushion to press against the surface of the rotating globe and thus replace the friction of the hand. An amalgam, consisting of a mixture of tin and mercury was spread over the surface of the cushion that was pressed against the glass by means of springs.

But the most important addition to the early machine of Hawkesbee was a metallic comb or series of points that, as shown in Fig. 108, were connected with an insulated metallic cylinder (B), known as the prime conductor or positive conductor of the machine. A similarly insulated metallic cylinder (A) electrically connected with a piece of metal containing the leather cushion, forms the negative conductor. When these two conductors (A) and (B) were brought near together by rods, (E) and (D) on the turning of the handle of the machine, the friction of the rubber against the glass, produced a series of electric sparks.

The action of the comb or points is as follows: The increased density of the charge at the points, produces, as already mentioned, an electric wind or convective discharge that is blown against the surface of the rotating plate, thus giving it a charge of the same name as that on the pointed conductor. This wind consists of molecules of air that have received minute charges from the electrified pointed surfaces.

It has been found that in order to obtain the best results in the use of the positive

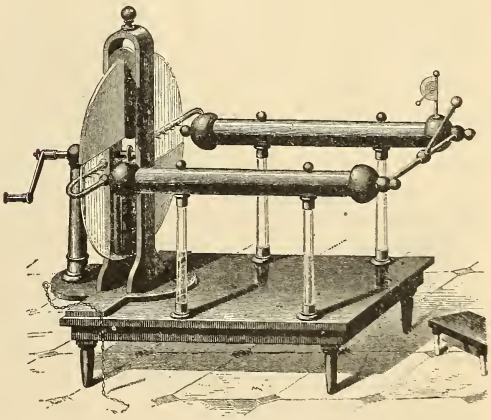


FIG. 109. RAMSDEN'S FRICTIONAL MACHINE

electricity produced on the prime conductor it is necessary to connect the negative conductor to the ground by means of a metallic chain.

A modification of the cylinder machine was the plate machine of Ramsden, represented in Fig. 109. Here, the glass cylinder is replaced by a circular glass plate mounted on a horizontal axis, so as to be rotated between two leather cushions covered with amalgam and placed, as shown, so as to press

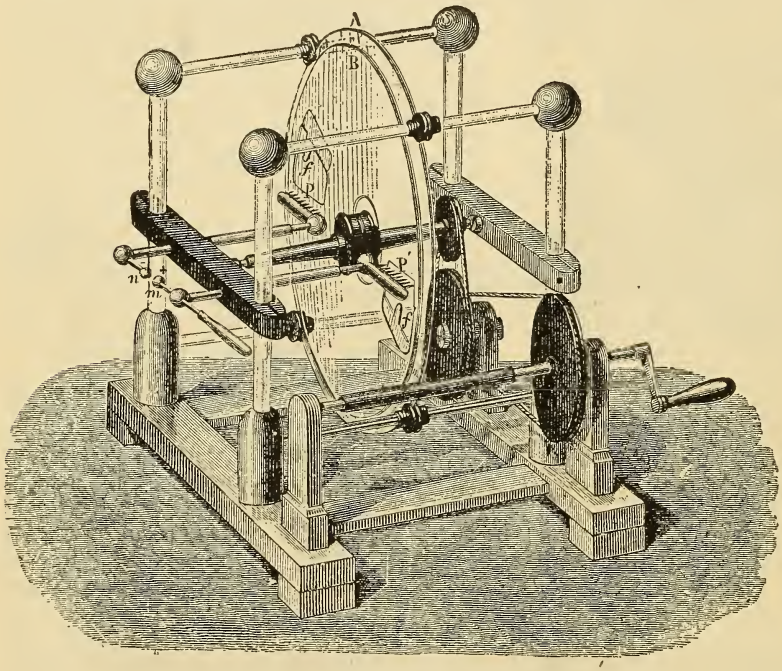


FIG. 110. THE HOLTZ MACHINE

against both surfaces of the plate at the upper and lower part of its diameter. On rotation, the plate becomes charged with positive electricity, which is conveyed to a prime conductor, consisting of two horizontal insulated cylinders, by means of a series of metallic points connected, as shown, with the cylinders. The best results are obtained when the negative charge, produced in the rubbers, is permitted to escape to the earth by means of the metallic chain represented in the lower left-hand side of the figure. In order to prevent a loss of electricity from the charged glass plate, quadrants of oiled silk are placed as shown so as to cover both sides of these portions of the plate.

A frictional electric machine has its best action when the air is dry and free from moisture. It is also necessary to avoid the collection of dust either on the surface of the glass plate, or on the conductors, since the dust particles acting as points, will permit leakage into the air, thus decreasing the amount of useful electricity obtained.

The older forms of frictional electric machines are now generally replaced by machines that operate on the principle of a revolving electrophorus. Such machines are known as electrostatic induction or influence machines. When properly constructed and operated they are capable of producing powerful discharges in practically all kinds of weather.

A common form of influence machine known as the Holtz machine is represented in Fig. 110. It consists of two glass plates (A) and (B), thoroughly insulated from each other and from the ground. The smaller of the plates (B) is so supported on a horizontal axis that it can be rotated close to the surface of (A) by the turning of the handle. The fixed plate (A) is provided with two large openings or windows, placed as

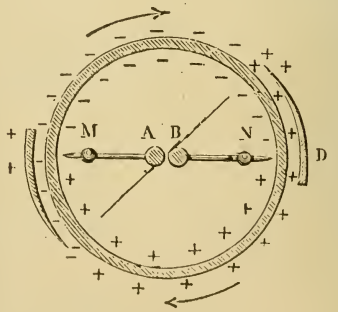


FIG. 111. DIAGRAM OF ACTION OF HOLTZ MACHINE

shown near its horizontal diameter. Paper bands or armatures (f), (f′), are glued to the plates across the windows so as to partially cover them. Each of these

armatures is provided with a paper point extending in a direction opposite to that in which the plate is rotated. Two metallic combs (P), (P′), placed opposite the windows on the side of the revolving plate furthest from the fixed plate, are connected with two insulated conductors that are provided with polished metallic balls (n) and (m). These conductors become respectively charged with negative and positive electricity. The distance between them can be altered by the movement of (m) towards or from (n) by an insulated handle.

In order to start the machine, (m) is brought into contact with (n), and one of the armatures, say (f), is charged by holding

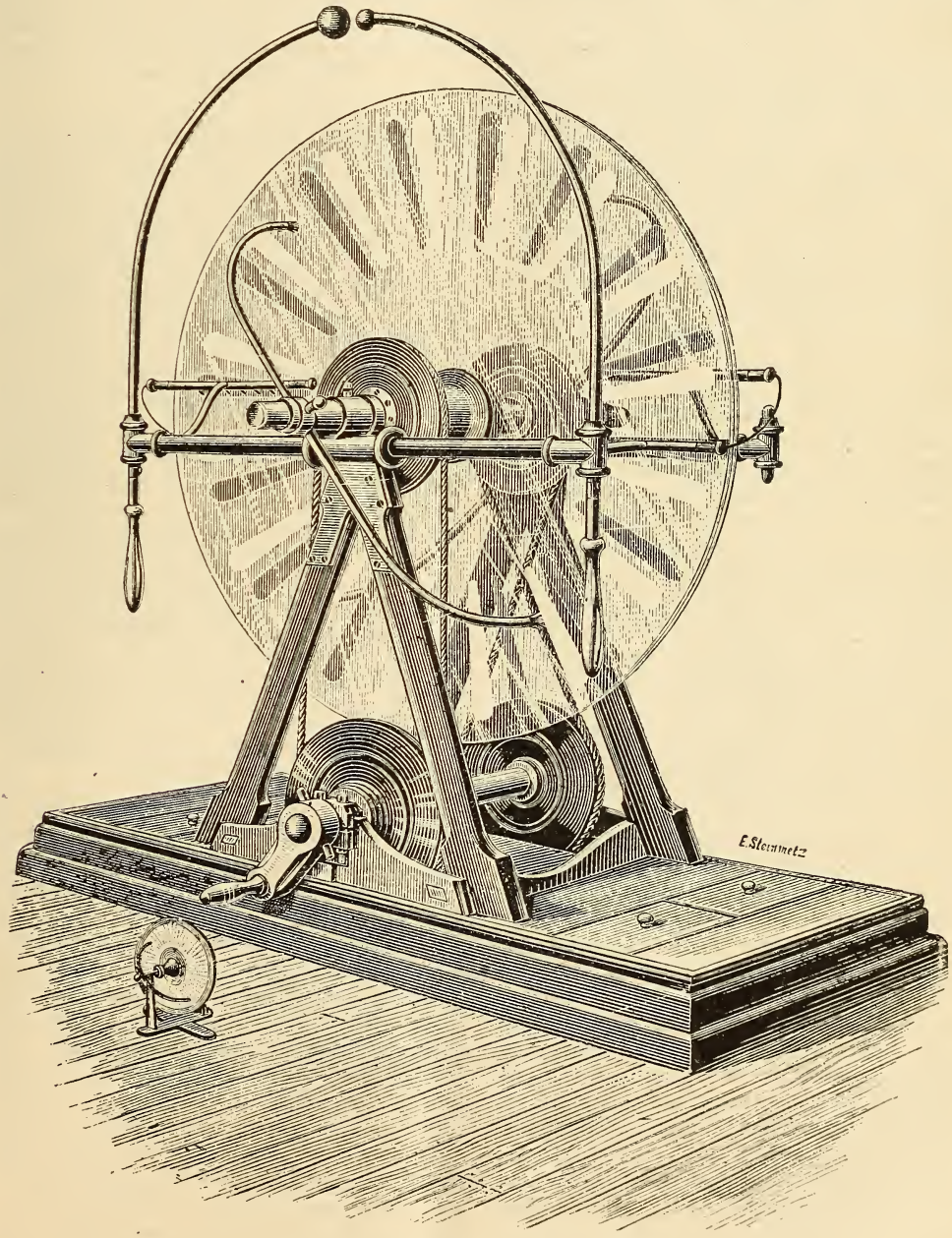


FIG. 112. THE WIMSHURST MACHINE

against it a sheet of vulcanite that has been negatively electrified by friction. After turning the plate for a few seconds the knobs are gradually separated when an electric discharge passes in the gap between (m) and (n).

The operation of the Holtz machine is thus described by Prof. Sylvanus P. Thompson, in his translation of Guillemin's "Electricity and Magnetism." In Fig. 111, the paper armatures on the fixed plate are represented by two segments (D). (A) and (B) are the conductors terminated by points (M) and (N) corresponding to the metallic combs of the machine. The movable plate is represented by circular lines so as to avoid confusion. The arrow shows the direction of rotation of the plate, which, as will be seen, is opposite to the direction in which the tongue of paper on each paper armature extends.

Suppose, now, that a sheet of rubbed vulcanite is brought into contact with the broad portion of the paper armature opposite (D), thus producing a positive charge in the near portions of the paper, and a negative charge near the tongue. The tongue now sets up a charge in the back of the rotating plate. Since the conductors (A) and (B) are in contact, the negative charge escapes from the comb (M) onto the glass, and a positive charge from the comb (N). The other paper armature is thus electrified by induction and a discharge of positive electricity from its point leaves its wide portion negatively charged.

The result of the above actions is to charge the rotating plate on both its front and back, one-half with the negative charge and the other half with a positive charge. The mutual reactions of these opposite charges from both the paper points and the comb rapidly increase until in a few moments the conductors can be drawn apart when a torrent of sparks passes between the balls (n) and (m).

There are a great variety of influence or induction electric machines. One of the most important is known as the Winshurst induction machine. In this machine, as shown in Fig. 112, there are two plates of glass that are rotated in opposite directions. Broad strips of metal foil, called sectors, are glued to the front of the front plate, and to the back of the back plate. These sectors act both as carriers and inductors. An uninsulated diagonal conductor, provided at its ends with metallic brushes, known as neutralizing brushes, is arranged so as to touch the front sectors at the ends of a diameter. A similar uninsulated conduc or extending in the opposite direction is placed across the back plate.

It is not necessary to start a Wimshurst machine by bringing a charged plate of vulcanite against any of its sectors, since the friction of the neutralizing brushes produces a charge sufficient for this purpose.

(To be Continued.)

THE ELECTRIC SYSTEM OF THE FUTURE

Philip Torchio, well known electrical engineer, made the following interesting forecast of the future developments of the electric light and power industry of this country, in a paper before the convention of the National Electric Light Association recently held in Atlantic City. "In the progress of the gradual uplifting of the industrial efficiency of the country, it is the province of the central station companies to furnish to the nation all of the power required by it in all commercial, industrial and agricultural needs. With thousands of central stations dotting the map of the United States from East to West and from North to South, with a closely woven network of power wires connecting the heaviest centres to the most humble hamlets, is it not reasonable to expect that this wonderful organization should ultimately command and control within this territory the generation and distribution of power for everything that lights, or heats, or operates machinery, or propels vehicles or trains?"

POWER TRANSMISSION THROUGH SPACE

It has been widely reported in the newspapers that electric current for the illuminations at the recent Omaha electrical show was furnished by wireless apparatus, and many were the rash statements about hundreds of horsepower transmitted through space. As a matter of fact no one has been able thus far to transmit anything like a small fraction of a horsepower, even, in this manner. What was done at Omaha was to simply send out waves as in wireless telegraphy, the power of which was comparatively insignificant. But the power was sufficient to affect a detecting device, as in wireless apparatus, and through this detecting device a secondary wire circuit

was closed, which, in turn, was able to close the circuit of the lighting current from the regular city light wires.

THE STORY OF ELECTRICAL WIRE

The very root and branch of the electrical business is wire. Millions of pounds of copper, iron and aluminum are made up into all sizes of wire every year. Some of these wires are as large as a man's wrist and others are so fine that a million feet of it would weigh but 25 pounds. Most of this wire has to be carefully insulated.

The telephone, the telegraph, signals, electric bells, the ocean cable, the electric light, and nearly every other application of electrical energy would be impossible were it not for the bars of steel and copper converted yearly into wire.

Excavations in Egypt have brought to the surface ornaments of wire, showing that the art of making it was practiced thousands of years ago. The method employed by the ancients was very different from that of the present, the old way being to beat metal into thin sheets which were cut into continuous strips, these being rounded by hammering and filing.

Apparently this method was employed until the fourteenth century when the steel die plate came into use. At first, wire was drawn entirely by hand, but in the latter part of the Fourteenth Century a machine was made to operate by water power and the production of wire became more of a commercial process.

The die plate was a German invention and nearly three centuries passed before it was introduced into England. For many years the industry was comparatively unimportant, but during the last half century the uses for wire have increased until it is now giving a service the value of which can scarcely be estimated.

To produce wire requires the treatment of a large number of metals, and varied processes of manufacture. Bars of metal, four inches square, are heated and passed while hot and plastic through rapidly revolving rolls, reducing them to wire rods which vary from one-quarter of an inch to an inch or more in diameter, depending upon the finished size of wire wanted.

These rods, which are formed into coils as they pass through the rolls, are dipped in acid baths to remove loose scale and provide a lubricant for drawing. Drawing consists of pulling rods while cold through holes of gradually decreasing diameter drilled in steel plates. During this process the particles of metal become elongated and strained, making the wire harder and more brittle. To restore it to a proper temper, it is necessary to heat or anneal it.

When a very fine diameter is required, there must be repeated annealings and drawings. This may be done until the bar, which originally was four inches square and four feet long, becomes reduced to a diameter of a single thousandth of an inch and extended 13,000 miles in length. Before so fine a size is reached the wire will cut into the steel of the die plate, so the usual die plates must be discarded and the drawing continued through holes drilled in diamonds, the diameter of these diamond dies decreasing by fractional parts of a thousandth of an inch. This wire affords a striking illustration of a material made more valuable by the application of labor.

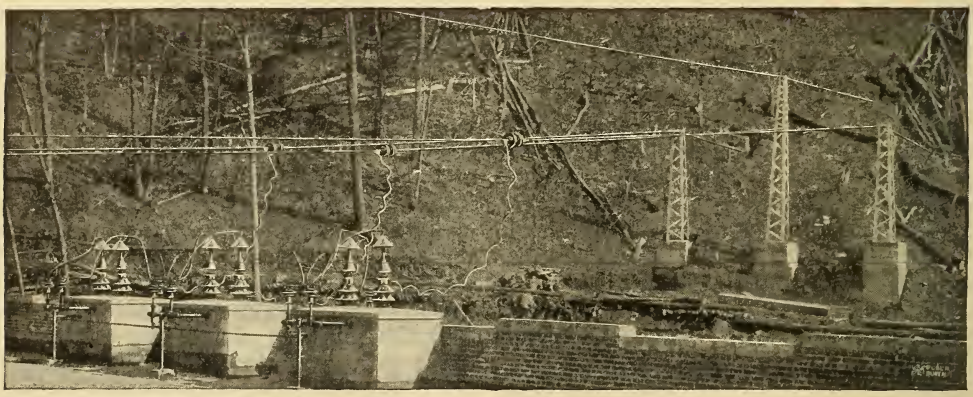
From the time the bar of metal enters the furnace nothing is added to it. All the work is done with one article which is passed through rolls and drawn through die plates until it is finished. Steel wire, for instance, may be made from an extra high grade of steel worth in the bar six cents a pound, which is much above the price of the greater bulk of steel. In the finished wire the value is increased from six cents to $50.00 a pound.

The insulation of wire for electrical work is one of the most important processes. If it wasn't for the many ingenious machines which cover all sizes of wire with the silk, rubber, linen and varnish insulating material the cost of all electrical devices would be far higher than it is today. The machine which winds the silk threads on the tiny copper wires, such as are used for electric bells, etc., works with almost human precision and wisdom and at a speed no human hands could hope to attain.

It was also found that electrical cables kept better if they were covered with a tube of common lead, so some genius set to work and perfected a machine to do this work. The cables, properly covered with insulating material, go in one end of this machine and come out of the other encased in a perfect tight fitting tube of shiny lead.

The wires, properly insulated, are wound on spools and reels and stored away until the time comes for them to take their place in the electrical world.

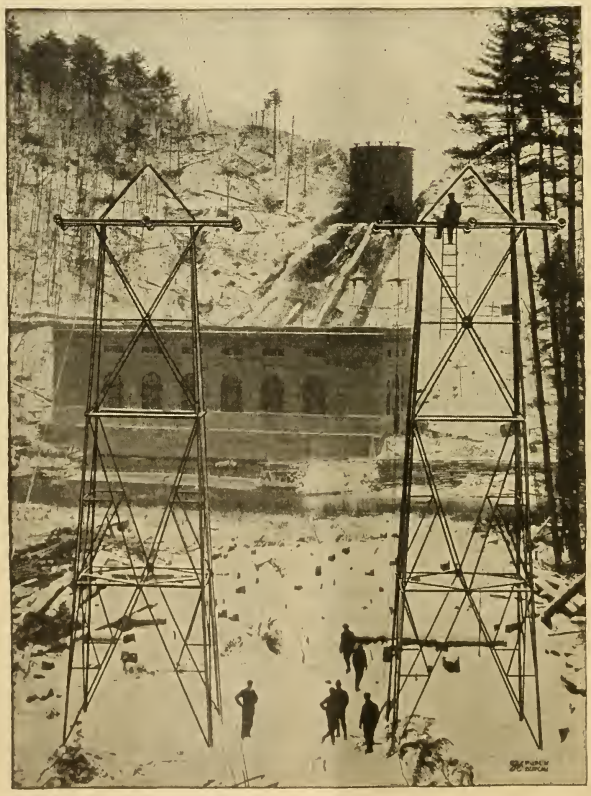
THE MAKING OF A TRANSMISSION LINE



THE WIRES EMERGE FROM THE ROOF OF THE POWER HOUSE

From Schaghticoke, on the Hoosic River, to Schenectady, in New York State, a distance of 21 miles, there stretches away across the country a line of skeleton steel towers which support six cables of hard drawn copper wire. Each cable is made up of seven strands, equivalent in all to a single wire a little less than half an inch in diameter, yet each three of these cables, forming what is known as a three phase circuit, is capable of transmitting 8000 horse-power of electrical energy, which is generated by the busy waters of the Hoosic and available in the distant city an infinitesimal fraction of a second after its production. Stand for a moment and watch the line. Not a spark is to be seen—not a sound heard. Yet in those insignificant appearing wires the power of 16,000 horses is confined and directed.

There is something mystifying and almost awe inspiring about the force which lives in these wires, though not more wonderful, perhaps, than the physical phenomena of light or heat or life; all indefinable. But the line itself, which we can see, is the work of man, and over it is transmitted this wonderful electric power, which he has never seen, and may never be able to exactly explain. The mechanical elements entering into the construction of a big power transmission line are therefore tangible and very interesting even to the layman. The accompanying views, obtained through the



BEGINNING OF THE LINE, SHOWING POWER HOUSE

courtesy of the General Electric Review, show some of these features.

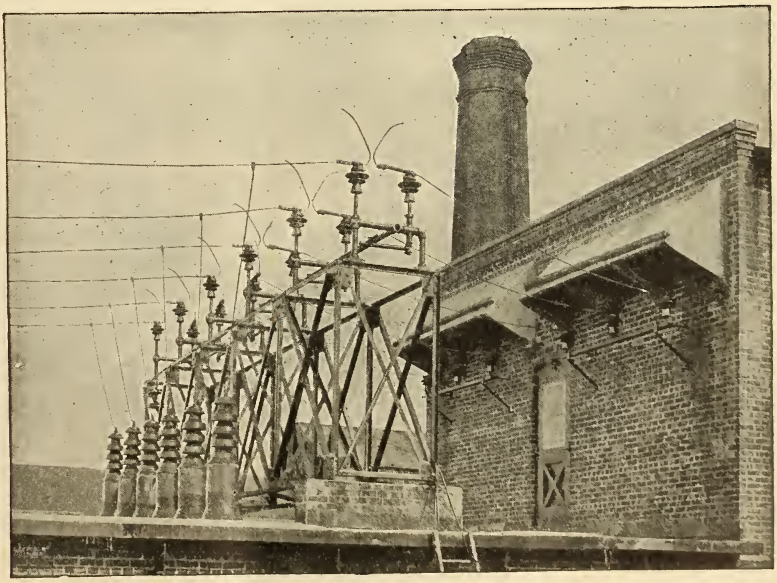
The current is generated by the water driven dynamos, transformed to 32,000 volts pressure, and the wires carrying it emerge from the power house to insulators mounted on the roof. Immediately over these insulators are stretched the line cables, held rigidly by anchor towers. The transmission cables and the terminals from the interior are then connected. One of the views shows the power house and first pair of towers and another shows the top of the power house and the anchor poles as described.

A LINE OF STEEL TOWERS ACROSS THE COUNTRY

Owing to the irregular contour of the country through which the line passes, the spacing of the towers varies within wide limits. The standard span is 600 feet, but other spans range all the way from 150 feet to 1263 feet in length, the latter distance being required where the line crosses Sanders Lake, situated near Schenectady. Where the line crosses the Hudson River the span length is 1125 feet; the line was carried across on standard angle towers. However, in order to obtain the required clearance, it was necessary to increase the tension at which the cables were strung to about 3000 pounds per cable, the average tension of the cables throughout the line being approximately 2300 pounds.

In designing the transmission line an extreme wind velocity of 85 miles per hour on the bare cable was assumed, or 40 miles per hour on the cable when coated with $\frac{1}{4}$ inch of sleet. Under these conditions, when strung on the towers, the cable would have to stand a stress of 4600 pounds, the normal operating tension, as stated above, being 2,300 pounds. But the cables were made to have a breaking strength of 7,500 pounds, so there is a large factor of safety.

Running along the tops of the towers and firmly clamped to each peak is a lightning guard wire made of $\frac{3}{8}$ inch stranded steel. This is the seventh wire seen in the picture



THE END OF THE LINE

of the line. This guard wire is grounded at every tower and has to date proved to be an efficient protection against lightning.

But how is the current prevented from escaping from the wires to the ground? This is provided for by disk insulators. These consist of solid disks of selected porcelain, laced together, by means of wire and drop forged steel links so that they hang one above another. They are then hung by the top to arms projecting from the towers and the transmission cables are hung from the bottoms of the strings of insulators. In order to reach the ground the current would have to puncture every one of the porcelain disks.

Finally when the line has reached the substation in Schenectady, where its pressure or voltage is to be transformed or "stepped down" to a low voltage practicable for use, a special construction was necessary to run the cables safely into the building. Here are some more heavy strain insulators to hold the stress of the cables. The dead ends are provided with horn gap lightning arresters, across which lightning bolts may jump if they get as far as the building, and be led to the ground without doing damage.

FIVE METHODS OF TRANSPORTATION

Something strikingly novel is shown in the accompanying illustration, for here, side by side, are five distinct modes of transportation, conditions probably not duplicated in any other place in the country. The photograph was furnished by Harrie P. Clegg, president of the Dayton and Troy Railway Company, of Dayton, Ohio. Dayton is the home of Wright brothers, famous builders of flying machines, and it is said that when the picture was taken, if the camera had been snapped in time, a sixth mode of travel would have been shown, for a flying machine passed over but a moment before.

From left to right the picture shows: first, the Miami River, a navigable stream; the Miami and Erie Canal; the high speed Dayton and Troy electric railway; the Cincinnati and Hamilton (steam) line; and finally the turnpike which was formerly the route of stage coaches.

VALUE OF CLASSICS TO THE ENGINEER.

In this intensely practical age we often hear the questions asked: "What is the good of studying Latin and Greek; why spend one's time delving in the dead languages of the past when the problems of the present are waiting to be solved? If we spend a certain period of our lives in obtaining an education, why not devote this study period to subjects of immediate practical value?" This tendency toward practical things has led to a great change in the curriculum of the modern university and college and as a

FIVE METHODS OF TRANSPORTATION SIDE BY SIDE

consequence the schools of technology—the practical schools—flourish as never before. But there is another side to the question, and we find it argued for by one of the foremost electrical engineers of the day, Mr. Charles P. Steinmetz. No more practical man ever lived than Mr. Steinmetz and, though a profound thinker along almost any line, and perhaps the greatest mathematician in this country today, he spends most of his time in putting his theories to practical use in his favorite field—electricity. Therefore when one so "practical" as Mr. Steinmetz upholds the classics, as he does in a recent paper before the American Institute of Electrical Engineers, it behooves us to weigh his words carefully if "we" are a young man about to enter college, or are parents seeking to give a son advice as to the pursuit of his electrical engineering education. The gist of the above mentioned paper is as follows:

"Education is not the learning of a trade or profession, but is the development of the intellect and the broadening of the mind, afforded by a general knowledge of all the subjects of interest to the human race, as required to enable a man to intelligently attack and solve problems in which no previous detail experience guides, and to decide the questions arising in his intellectual, social, and industrial life by impartially weighing the different factors and judging their relative importance. These problems, and thus the educational preparation required to cope with them, are practically the same in all walks of life, and the general education of mind and intellect, required by the engineer, the lawyer, the physician, etc., thus is essentially the same. The only legitimate differences in the training for the life's work, required by the different professions, thus are those pertaining to the specific instruction and study of the details of the particular branch of human knowledge, by which the student desires to make his living.

"For ages the classics, comprising the study of the Latin and Greek languages and the literature of these languages, has been the foundation of all education; but in the last two generations it has been more and more pushed into the background by the development of empirical science and its application, engineering. It is my opinion that this neglect of the classics is one of the most serious mistakes of modern education, and that the study of the classics is very important and valuable, and more so in the education of the engineer than in most other professions, for the reason that the avocation of an engineer is specially liable to make the man one sided. By dealing exclusively with empirical science and its applications, the engineer is led to forget, or never to realize, that there are other branches of human thought besides empirical science, and equally important as factors of a broad general education and intellectual development. An introduction to these other fields is best and quickest given by the study of the classics, which opens to the student other worlds entirely different from our present, the world of art and literature, of Hellas, and the world of organization and administration—and of citizenship—of Rome, and so broaden his horizon beyond anything which can be accomplished otherwise, and show relative values more in their proper proportion, and not distorted by the trend of thought of his time.

"It is true that the classics are not necessary if the aim is to fit the student to ply the trade of engineer, just as that of plumber or boiler maker, and the world, and especially the United States, is full of such men which have learned the trade of engineer. But such learning of the engineering trade can hardly be called receiving an education, and certainly does not fit the man to intelligently perform his duties as citizen of the republic during the stormy times of industrial and social reorganization, which are before us.

"The modern languages are not in the same class with the classic languages, as they open to the student no new world, no field of thought appreciably different from our own, and I therefore consider them of practically no educational value. Their utilitarian value to the college student is negligible, as due to the limited time, the absence of practice, and the large number of other more important subjects of study, very few of the college graduates retain even a rudiment of their knowledge of modern languages, and even those few only because they are especially interested in them, have occasion to practise them, and therefore would probably have learned them outside of college. To the engineer particularly, the knowledge of foreign modern languages offers no appreciable help in following the engineering progress of other countries, as

practically all that is worth reading is translated into English either in full or in abstract, and engineering publications written in a foreign language are closed to the reader, even if he has some knowledge of the language, by his lack of knowledge of the technical terminology of the foreign language. Since the modern languages have no appreciable educational value, they should be dropped from the engineering curriculum of the college, as their retention violates the principle of the modern college curriculum, to restrict, due to the limited available time, to that instruction which the student can not acquire outside of the college by self study, or can acquire only under great difficulties.

THE NEPTUNE CAP

The dread of a sea voyage, due to sea sickness, amounts with some people almost to actual terror, and those who have experienced the sensation know that this terror is not without foundation. Various expedients have therefore been tried to alleviate the torture, among them the "Neptune Cap," an invention of one Herr Paul Kappmeir. He states that he has studied the subject for many years and made numerous experiments and observations, and he has come to the conclusion that the principal cause of sea sickness is a reflex irritation of the cerebral vasomotor nerve, the fifth and tenth pair of nerves being likewise involved in the trouble.

THE NEPTUNE CAP TO PREVENT SEA SICKNESS

The electric Neptune Cap consists of a compress, the employment of which tends to overcome sea sickness. The inventor states that the treatment consists in providing pressure to act upon the head, in the form of a compress, together with an application of heat. He maintains that the compress acts upon certain of the arteries of the head, without, however, prejudicially affecting the main artery, which is so important in its action. By the equipment of modern steamers with this new device he says that every passenger may be assured of enjoying his or her sea voyage without the disagreeable sea sickness due to the motion of the boat.

Heat necessary for the treatment is derived from electric current which is made to circulate through resistances located in the compress.

ELECTRICITY VS. GAS IN VENTILATION

BY C. M. RIPLEY

It costs money to purify anything; whether it be the Panama Zone that must be made habitable—or a political situation which requires a housecleaning. Such worthy enterprises require considerable expenditure and there will always be found some who protests. Even our Pure Food Law came in for its share of complaint, and now we learn that the New York Labor Law requiring a supply of fresh air for the employees of workshops and factories is being subjected to some criticism.

The law reads as follows:

"The owner, agent or lessee of a factory shal provide, in each workroom thereof, proper and sufficient means of ventilation, and shall maintain proper and sufficient ventilation; if excessive heat be created or if steam, gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein, the rooms must be ventilated in such a manner as to render them harmless, so far as is practicable."

Mr. William W. Walling, Chief Factory Inspector for the State of New York, interprets the law as follows:

"As defined by Dr. John S. Billings, perfect ventilation means that any and every person in a room takes into his lungs at each respiration, air of the same composition as that surrounding the building, no part of which has recently been in his own lungs or those of his neighbors, or which consists of the products of combustion generated in the building, while at the same time he feels no currents or drafts of air, and is perfectly comfortable as regards temperature, being neither too hot nor too cold.

"How much air is required to meet these conditions?

"Not less than 2,000 cubic feet per hour for each person, with the same amount per hour for each cubic foot of gas consumed whether for light, heat or power."

Some landlords in New York City have put forth the claim that the amount of fresh air specified by the Department of Labor was an "arbitrary quantity." Several authorities on the subject of ventilation who have been consulted in the matter and who are also entirely disinterested—agree that 2,000 cubic feet per hour per person is common practice and is based upon definite laws or rules which have been followed for many years in the design of ventilating systems.

On the above basis in a loft 25 feet wide and 100 feet long, containing 80 workmen, and lighted with electricity, the amount of air required would be 80 times 2,000=160,000 cubic feet per hour. This amount of air per hour would move at the rate of about $\frac{1}{8}$ of a mile per hour—and would be sufficient to change the air in the loft six times per hour, assuming a 10-foot ceiling. Since the Massachusetts and New York State laws for school rooms require eight changes per hour and since some authorities recommend even 50 per cent excess of this—it appears that the action of the Factory Inspector hardly comes within the definition of the word "arbitrary."

Regarding the use of gas lighting Dr. Daniel R. Lucas of New York City states that it is a well known law of hygiene that one gas jet will consume as much oxygen as five persons. Since electric lighting—thanks to the new high efficiency lamps—has been reduced in cost 50 per cent or more, it appears that the easiest way to comply with the Labor Law regarding ventilation would be to abandon gas lighting.

Since the average gas light is equivalent to five persons, as far as its vitiating effect is concerned, it can be readily seen that the ventilation required will be reduced 5-6 by abandoning gas light, assuming one gas jet to each workman. Or stating it in another way, the landlord who clings to gas lighting must install ventilating apparatus six times as large as would be necessary if electric light were used. This calculation is also based upon conditions where one gas jet is provided for each workman.

The operating cost for a ventilating system is made up of two items: (1) Power for turning fans; (2) additional heat for incoming air. In a loft building where the tenant will pay for the power, the expense will automatically be divided and the landlord will pay for the extra heat required since heat is included in the rent. It will also be noticed that again the adoption of electric lighting will cut the bills for operating expenses to a remarkable degree. This cut in expense will affect the tenant, since a much smaller ventilating motor will be required, and it will also affect the landlord because less air will have to be drawn in and hence the cost for heating will be diminished.

HOW ELECTRIC TRAINS START SMOOTHLY

BY ALBERT WALTON

An inkling of the desirability of starting smoothly is received and usually remembered by any one who has had the misfortune to ride on an ordinary trolley car behind a green motorman or one who seemed bent on making his passengers suffer for his own ill temper or nervousness. If one has experienced that sensation of "neck-snapping" that comes with the too rapid starting of a car he knows at least one of the points wherein a careful motorman excels an ignorant or willful one. The same thing that makes it uncomfortable for the passengers is also hard on the electrical apparatus as well as the parts under the car.

THE MASTER CONTROLLER

On roads where trains of electric cars are run such as elevated railways, subways and electrified steam roads items like waste of power during starting, deterioration of apparatus due to heavy rushes of current and discomfort of travelers, all become of prime importance and steps must be taken to insure economy and smoothness.

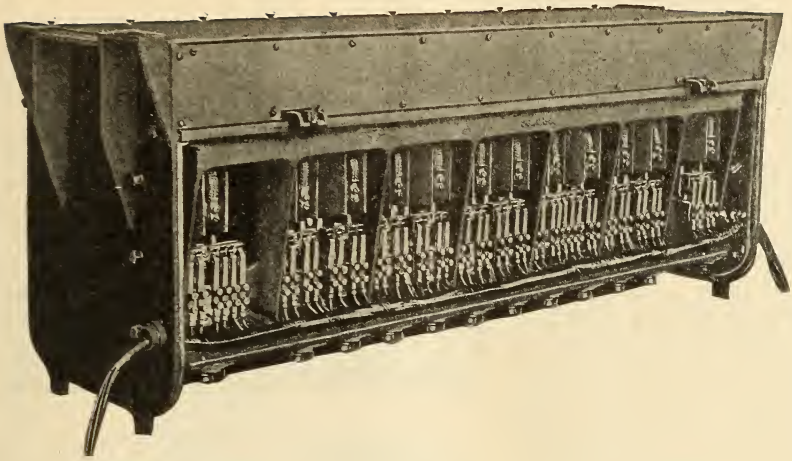
Even though it is possible to employ a more intelligent class of operatives on such roads, it is still found that damage to apparatus occurs, and temptations to make up lost time prove so great as to cause even the older and more skilled motormen to overdo the speeding up after a stop.

In addition to this is the fact that it is no longer a question of starting a single car from the motors mounted on that car. Trains of six or seven or more cars are run as a unit in each train and no one car has power enough to start the whole train quickly enough to meet the requirements of modern rapid transit. So in a train of seven cars it is necessary to have at least four of the cars equipped with motors. Not only would it be expensive to have a motorman on each of these cars, but even should this be done, the troubles of the single car would be multiplied by four. They would not start together and one set of motors would for an instant be trying to do the work of four and then, perhaps, all would get in at once and the train would give a lurch that would take the strap-hangers off their feet like a row of dominoes. Power would be wasted and machinery injured.

In order to get all the cars of a train to start at the same time and to start as rapidly as possible without discomfort or damage, the whole operation is now made automatic. The motorman sits in his little cab in the front car and moves a handle on a little cylinder to one side and instantly, in all the cars, switches, worked by air pressure, are connected so all the motors start together. Without further motion on the part of the motorman these switches are then closed step by step so the cars gain more and more speed until they have attained about half their best rate. Then, if it is desired to increase this speed the motorman is called upon to make a second motion and throw the handle to the second notch. Smoothly all the cars throw on their additional power in gradual increments till full speed is reached. The rate at which the speed increases is beyond the power of the motorman to control. It is fixed at the shops so that all he has to do is to start the mechanism working and let the compressed air and the magnets take care of the rest.

For example, the valves can be set so a six-car train will come from rest to half speed in ten seconds, and it will do this every time, regardless of the man in the cab. All the motors do their proportional share of the work and the valves are so arranged that the air is not permitted to close a switch to give more power to the motors, till the train has increased its speed enough so the throwing in of additional power will not cause a jump in speed.

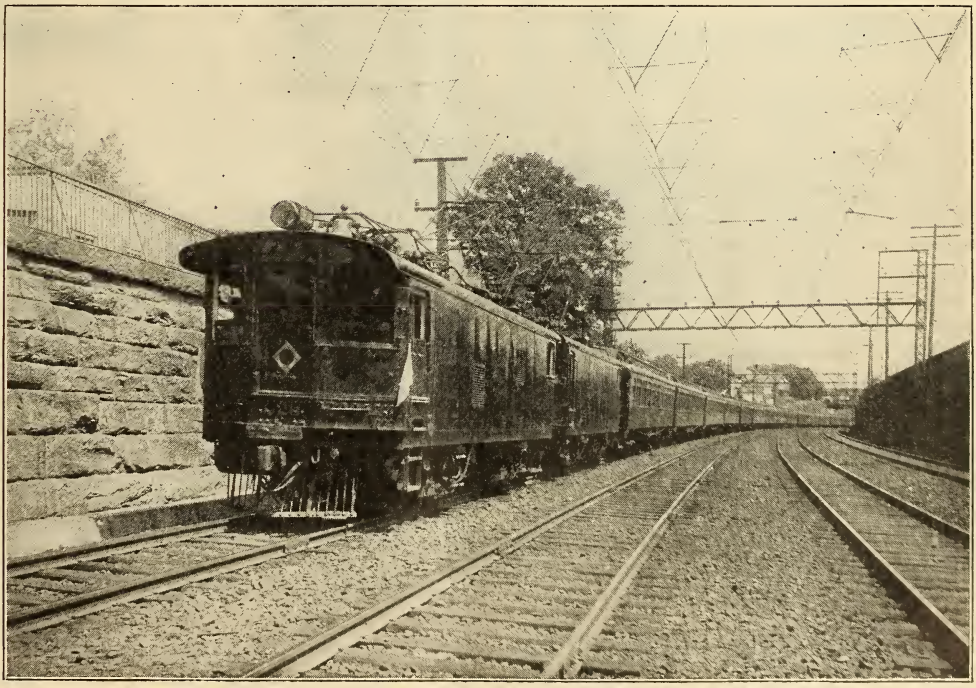
In these automatic systems the motorman does not work at all with the current that runs the motors. He simply turns on and off a current that comes from a small storage battery on the train. This current operates



THESE SWITCHES CLOSE AUTOMATICALLY STEP BY STEP

small magnets which open valves admitting compressed air from the air-brake pipes into small cylinders. By this compressed air the switches which handle the main current from the third rail or trolley wire to the motors are opened and closed in regular order. They are so inter-locked that it is impossible to throw the wrong one first or to throw them in anything but the right order and at the right time to give the predetermined speed.

Furthermore, in the latest systems, if the motorman should take his hand off the little handle in the cab the train would be brought to a stop, for it is necessary to actually hold it in place to keep the current on, a spring tending to throw it back to the stopping position at all times. This arrangement is provided so that if a motorman should faint or fall asleep, due to overstrain, the cars would stop of themselves and no damage result. If anything should happen to the air-brake system so the pressure should become reduced, this, too, would stop the train, for the switches are also held in place against springs which will open them if the air pressure is removed. In fact, when the motorman wishes to stop his train, all he does is to move the lever back to the stopping



MULTIPLE UNIT CONTROL APPLIED TO ELECTRIC LOCOMOTIVES

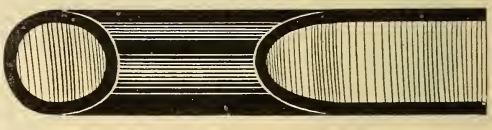
position which cuts off the air pressure and allows these springs to open the switches and cut the current off the motors. This is done on all the cars of the train at the same time. In this way the motor current enters each car directly from the wire or rail and does not have to be sent from one car to the next. All that has to be carried from car to car is the small current from the storage batteries to operate the little magnets on each car.

This multiple unit system has been used on city elevated roads for a number of years to control the speeds of the trains that are run by electricity. It is now being used on a larger scale by the steam roads that have installed electric traction for part of their equipment. It is very convenient, also, on such roads as are using electric locomotives to haul regular passenger trains the coaches of which are not equipped with motors. If one locomotive is not heavy enough to do the work another is added in front of it, the motorman gets into the front cab and the two machines then act as one with twice the power yet still under the hand of the one man. If two are not powerful enough more can be added as desired and yet one engineer runs the group with the same motions and the same ease as he would with one single machine. And the speed will be smooth and the motors protected from damage while the passengers feel even less motion than was felt with the old steam locomotives.

A NEW ELECTRICAL WIRE

Two elements enter into the requirements for wire used in the transmission of electric current; namely, conductivity or ability to pass the current with little resistance and mechanical strength. Now copper has very high conductivity but its strength is not nearly as great as that of steel, which latter, however, has low conductivity. In using wire made entirely of copper for telephone and telegraph lines, particularly if long spans are desired, a larger copper wire than would be actually necessary to pass the current must be used, in order to obtain sufficient mechanical strength to stand the stress placed on the wire; and copper is too costly to use much in excess of the actual requirements. This high cost of copper makes it necessary to use iron or steel wire for most telegraph and telephone lines, although copper is really better.

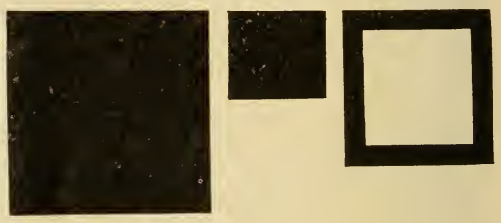
As a consequence of these conditions a new kind of electrical wire has been invented which has a core of steel to give mechanical strength, and an outside coating or jacket of copper to give the necessary conductivity for the flow of the electrical current. In making the wire a billet of steel with a jacket of copper is rolled and then drawn as in making ordinary wire, and the result is a wire with



COPPER JACKETED STEEL WIRE

a core of steel, the copper jacket being actually welded to the core so as to form a homogenous mass.

What this new wire really means to electrical construction is graphically shown by the three squares. Taking an imaginary case where a given resistance is allowable per mile of wire; if all copper wire were to



COMPARISON BETWEEN ALL COPPER AND THE NEW WIRE

be used, a No. 12 copper wire would be necessary to obtain the required strength, its cross section would be represented by the large square at the left, its elastic limit would be reached at 184 pounds and it would cost $16.43 per mile. The middle square represents the size of wire which would be actually required as far as electrical conductivity is concerned (No. 18), but it wouldn't be strong enough. Its cost would be $4.33 per mile. The hollow square represents the relative size of the copper clad wire (No. 14) which would do the work, the black portion representing the copper. This wire would have an elastic limit of 320 pounds, stronger than the No. 12 pure copper; it would have nearly the conductivity of the No. 18 pure copper and it would only cost $8.41 per mile .

DETECTING CURRENTS

Persons connected with the operating departments of electric light and power companies have felt the need of a satisfactory device for determining whether current is flowing in a cable or not. Valuable time is frequently lost in locating trouble owing to the trouble men not being provided with

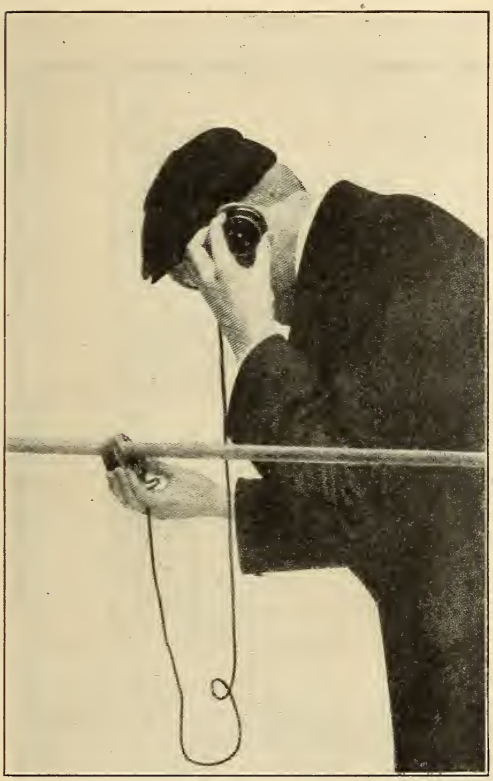


FIG. 1. DETECTING CURRENT BY MEANS OF A TELEPHONE

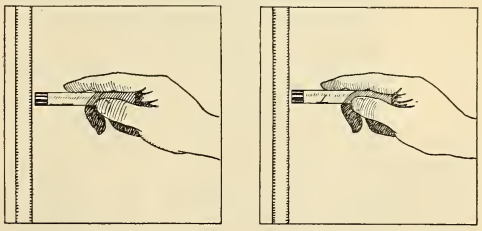
satisfactory testing outfits. Accidents have also occurred due to jointers cutting cables which they supposed to be "dead." Any system of numbering or tagging cables is likely to become wrong, due to changes, and should not be depended on absolutely, particularly with high tension cables.

The compass method of testing, while generally satisfactory for direct current cables, will not answer on alternating current. The testing outfit illustrated in Fig. 1 is designed for use on alternating current lines, but is also satisfactory for direct current work, provided the current is supplied from a generator. It would not work on a battery circuit, as the sound heard depends on the commutating action of the generators.

The testing outfit consists of a telephone receiver and a small current transformer with a hinged core. The secondary wiring of the transformer is connected to the telephone receiver and the hinged core is clamped around or against the cable to be tested, the cable forming the primary of the transformer.

The device will be found very sensitive, and will work on single, duplex or three-conductor cable. It will be more sensitive on single conductor cables than on the others. On single conductor cables an alternating current of one ampere, or a direct current of two amperes, will give a distinct, audible indication in the telephone receiver.

The electroscope, Figs. 2 and 3, was devised for the purpose of affording a rough-and-ready means for determining the presence of a dangerous potential in an electrical conductor. Workmen are thus enabled to make their own determinations and take their own precautions against danger to life before touching any electrical conductor that may carry a dangerous potential.



Conductor "Dead" Conductor "Alive"

FIGS. 2 AND 3. USE OF THE ELECTROSCOPE

The device consists of a glass tube, in which is hermetically sealed a copper plate carrying the indicating foil leaf. In using, the end of the electroscope is held in close proximity to the conductor to be tested. It will indicate positively all potentials in excess of 500 volts. If the conductor is "dead," the indicating leaf will remain flat. If the conductor is "alive" the indicating leaf will tend to take a position at right angles to the tube. It will not, however, work on a grounded conductor, or a conductor surrounded with a lead sheath.

A powerful electric blower has been devised for plucking chickens. When the dead chickens are placed in the strong suction all the feathers and down are quickly removed.

ELECTRIC RAILWAYS OF SPAIN

BY DR. ALFRED GRADENWITZ.

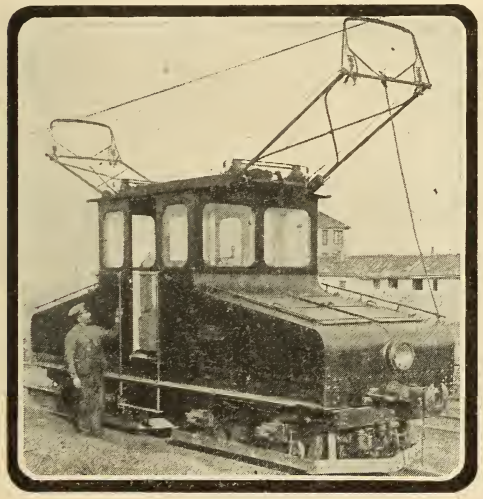
In far away Spain electric railroading is not carried on under conditions prevailing in this country, and it would be reasonable to suppose that we would not find there electric railways operating on as extensive a scale as here, where there are so many more people. Then too, methods of operation which might be highly satisfactory to the more easy going Spaniard would probably not be swift enough in this land of the hurry-ups.

Nevertheless the modern cities of Spain have very well equipped electric railway sys-

tems admirably designed to meet the requirements of their citizens. Santander, for instance, an enterprising industrial town, has a new electric railway system, connecting it with Penacastillo and Astillero.

As in this country direct current is used, of 500 to 600 volts pressure, but the method of collecting the current from the trolley wire is different. There they use what is known as the bow trolley instead of the trolley pole and little wheel so commonly seen on our streets. This would look a little peculiar to us at first.

There are in all just 18 cars operating on this system. Those used within the city limits are able to accommodate only 18 passengers. To handle the rush hour traffic in one of our large cities with cars of this size would be like filling a bath tub with a teacup. But it must be remembered that Santander is a small city, and its people are not in a hurry to get down to work in the morning on the minute. Therefore the small cars serve them adequately and are at the same time models of neatness and well kept-up equipment, judging by the pictures.



The interurban traffic between the above named cities is expected to develop to a large degree, so a number of electric locomotives, similar to the one shown, have been procured, which are capable of drawing several cars in a train.

One of the first electric locomotives was built by Stephen D. Field, of Stockbridge, Mass., and the motor is still preserved in the cellar of the Field house as souvenir.

FACTS ABOUT LIGHT AND LIGHT SOURCES

The source of all light is a substance which is raised to such a temperature that it sets up waves in the surrounding air, which, when falling upon the eye, produce the sensation we know as light. It is acknowledged that the source of light in the sun is a great mass of white-hot matter and the source of light in an arc lamp is the heated gas between the carbons which are raised to a high temperature by electricity. In an incandescent lamp the light source is a thin filament inside the glass globe which is maintained at a high temperature by the passage of a current of electricity.

The character of light given off by the different illuminants depends upon the source; for instance, the old carbon filament lamp gives off light which has an abnormal amount of red in it, while the new tungsten filament has more nearly the proportion of daylight. This difference in the quality of light is due to the difference in temperature at which the filaments operate. Tungsten can be operated at a much higher degree of heat than any other form of filament.

To fully understand light one has to assume the presence of a wave motion set up and maintained by the source itself. The color of the light depends on the length of the wave. The light waves producing the colors in the blue end of the spectrum are very short compared with those that produce the colors near the red end. The light source which we know as red gives off only waves of the length which produce that particular color. A body appears red because its surface is capable of reflecting only waves of lengths corresponding to red. If we attempt to illuminate a blue body by a red source we will fail, because the blue body is capable of reflecting only the short waves producing the blue, and since the red source contains none of these there will be no reflection and the body will appear black. If we have objects of a variety of colors, and wish to display them in their true relation, we must evidently have waves of lengths corresponding to every color we wish to display. The ideal conditions would be to have a source of light that would give out waves corresponding to all colors; in other words, a white light. We see objects by the light reflected from them, and since all surfaces do not reflect the same per cent. of the

incident rays, it is evidently necessary to display them under different light intensities to have them appear equally illuminated. In a department store we may have white goods displayed on the same floor as dark woolen goods. In this case if the intensity of the light is the same throughout the store, the section containing the dark goods will appear poorly lighted as compared to the section containing the white.

This property of surfaces of reflecting, or rather absorbing light, is shown in the following table, which gives the per cent of the total incident light that is reflected.

Mirror	95.
White blotting paper	82.
Chrome yellow	62.
Orange	50.
Yellow	40.
Pink	36.
Emerald green	18.
Dark brown	13.
Vermilion	12.
Black paper	0.5
Deep chocolate	0.44
Black velvet	0.4

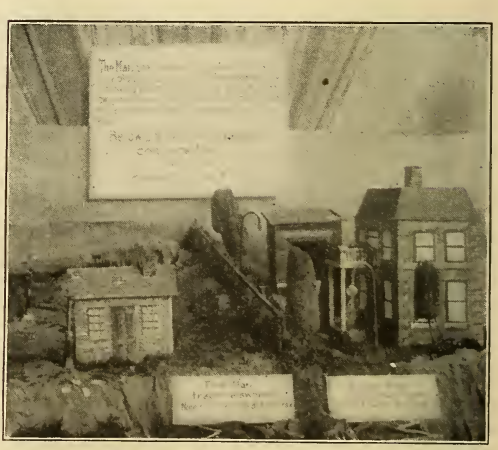
The question of reflection depends also on the angle at which the ray of light strikes a surface. Take, for instance, the polished surface of a plate glass and give the ray of light an angle at which the light no longer penetrates the glass, and it will be totally reflected.

The quality and distribution of the light as it is given off from the light source is quite often changed by transmitting the light through substances other than air. The things that are true in connection with reflection can be applied, in a great measure, to transmission. Thus a piece of glass when held up to a light appears some particular color because it transmits waves of the length corresponding to that particular color. If we attempt to transmit white light through a red glass only the red ray will be transmitted, the others being absorbed by the glass. Instead of getting all the energy of the white we get only that part included in the red ray. If we have a light source which contains an abnormal amount of light of some colors and the correct proportion of others, we may correct this by inclosing the source in a glass globe of such a character that it will absorb the excess light of the colors which are abnormal, thus giving a white light. A case of this is found in the arc lamp, which has an excess of blue and violet. This may be corrected in a measure, but the quality is obtained at the expense of efficiency.

The question of the color of light is of very serious moment to storekeepers and clothing houses or other places where colors have to be matched. Until the new tungsten metal was discovered for incandescent lamps this work could not be done after dark because all the artificial illuminants carried too many foreign light waves. But the tungsten lamp so nearly approaches the clear white light of actual sunshine that in nearly every instance it can be used to take its place.

UNIQUE WINDOW DISPLAY

Considerable ingenuity is shown in the design of the allegorical window display of a prominent electrical supply dealer in Minneapolis. The story it tells is this: The man who uses electricity in his home is the progressive citizen. His surroundings are almost certain to be pleasant and indicative of prosperity. On the other hand the man who has not progressed far enough



UNIQUE WINDOW DISPLAY

to recognize the benefits and economy of electricity is more apt to be found surrounded by conditions much lower in the scale of living. Moral: Character is largely determined by environment. Use electric lights as the first step in bettering living conditions; it will lead to other improvements.

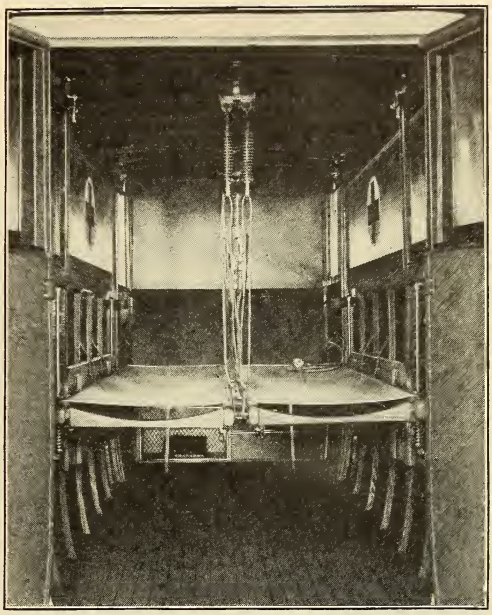
A peat-gas plant is being erected near Svedala, Sweden, which will transform power from the heat in peat into electricity, and this electric power will be conducted to neighboring towns for consumption by municipalities and industrial plants.

MODERN ELECTRIC AMBULANCES

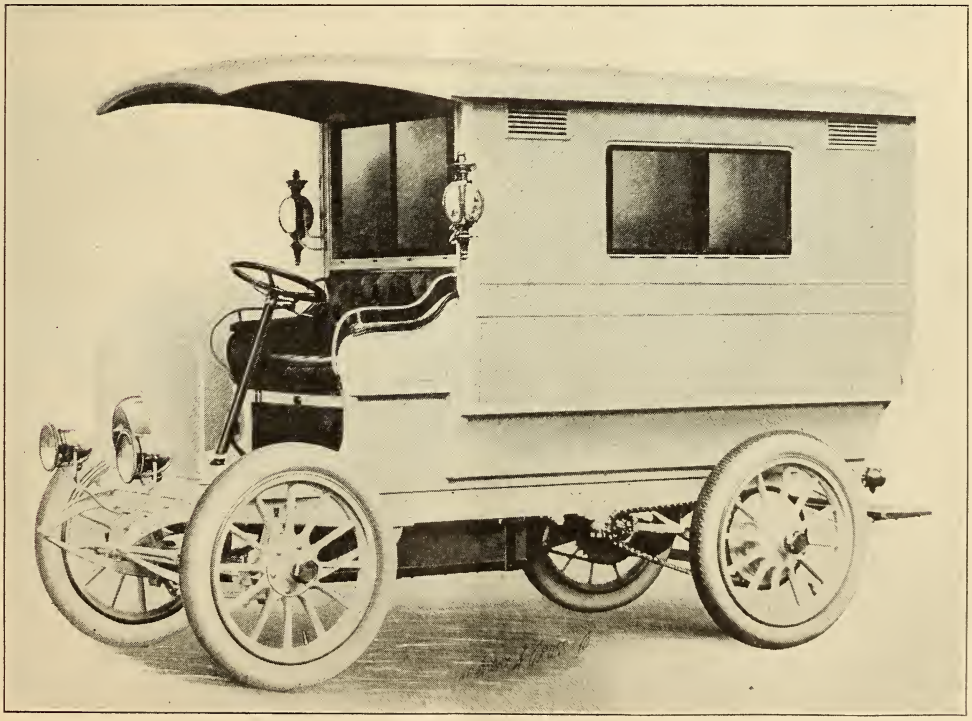
The clang of a gong, the flash of a swiftly moving white vehicle, and the electric ambulance has come and gone almost before we have had time to be aware of its approach. Once inside, its stricken passenger hardly knows that he is riding, so carefully has everything been arranged for his comfort. There is no sound of thundering hoofs, no vibration of a gasoline engine. By means of a special controller for the motor, the ambulance is started and accelerated without shock, and a speed of 20 miles an hour may be obtained in cases of special emergency.

A type of electric ambulance operated by the Board of Health of Indianapolis is shown in the illustrations.

This electric ambulance is provided with two folding seats on the side, the cot being 85 inches long and 26 inches wide. The cot base is $16\frac{1}{4}$ inches above the floor and hinged so that it can be raised when desired. The cot is adjustable for reclining, the lining being removable for sanitation. There are three drawers in the base for medicine and instruments, and the interior and exterior are finished in white with red upholstering.



INTERIOR OF AN ELECTRIC AMBULANCE



A MODERN ELECTRIC AMBULANCE

This electric ambulance is said to be economical in the use of current and far more reliable than gasoline equipment, while the storage batteries allow the use of electric lights at night inside and outside and are a great convenience to the surgeons. It is maintained that the electrically driven ambulance is particularly well adapted for town as well as city service. Its batteries may be readily charged from any direct current lighting circuit and a small motor generator set or mercury converter being all that is necessary on an alternating current system.

ELECTRICITY IN THE WHITE HOUSE

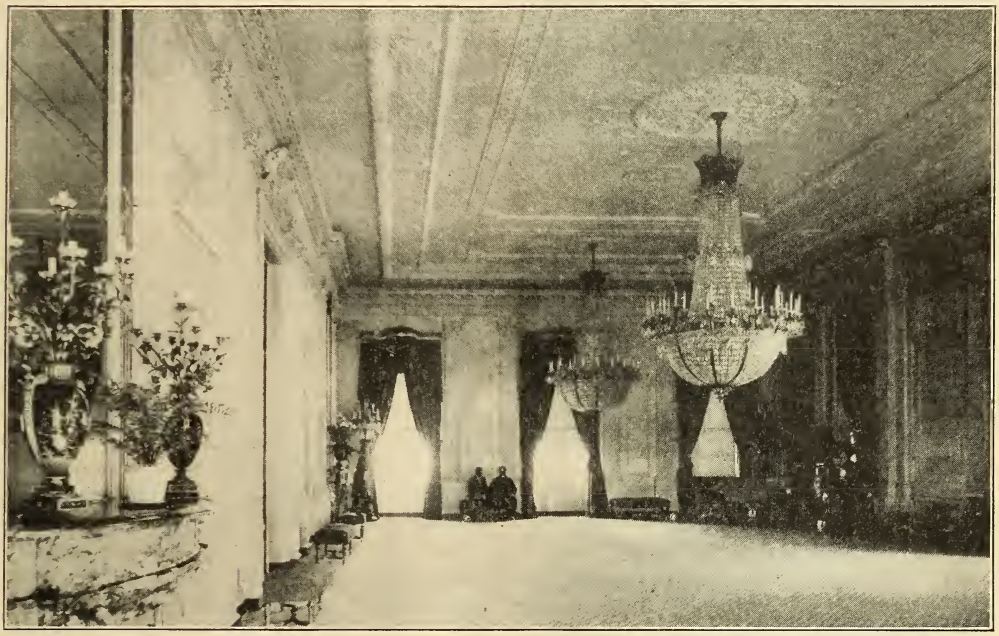
ENTRANCE TO THE WHITE HOUSE AT NIGHT

Electricity is the only illuminant employed at the White House in Washington, and, as is befitting the home of the nation's chief magistrate, the electrical installation is in many respects the most elaborate and the most complete to be found in any residence in America. There are in the presidential mansion and the White House office building adjoining, a total of 1,800 incandescent lamps—some of 16 candle-power, but a good proportion of 32 candle-power each—as well as a number of arc lights, the latter being employed particularly for lighting the grounds and drives and illuminating the exterior of the mansion so that no person could approach the President's home at night without being seen by the secret service men and police officers on guard. A considerable portion of the electric lights at the White House are in use during every hour of dusk or darkness, week-days and Sundays, from one end of the year to the other, so that it can be appreciated that merely the maintenance of this lighting system, the renewing of lamps, etc., is a considerable chore.

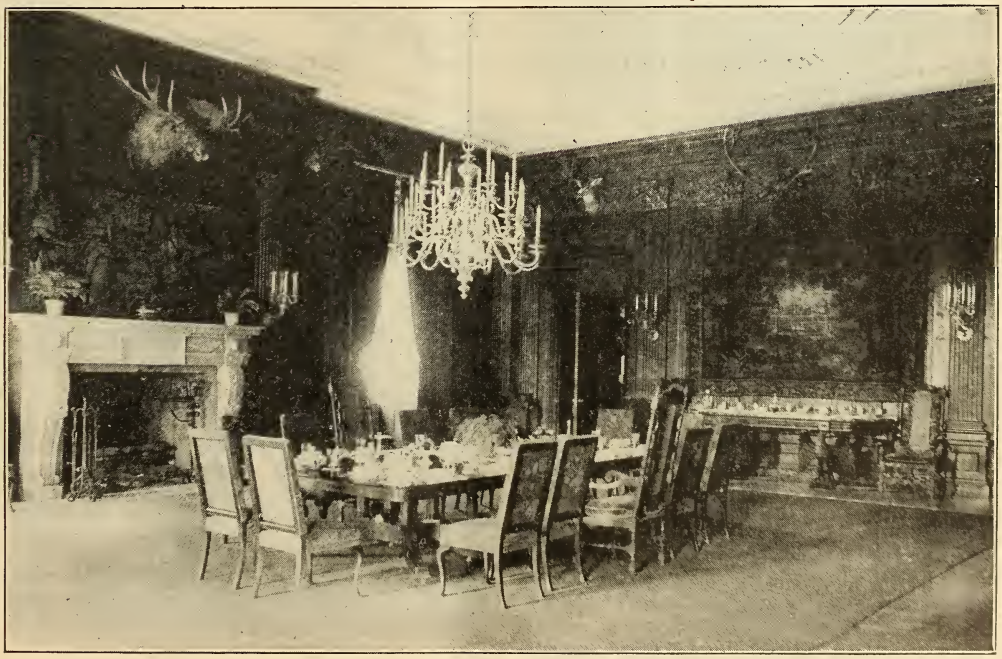
THE RED PARLOR

When, early in the first Roosevelt ad-

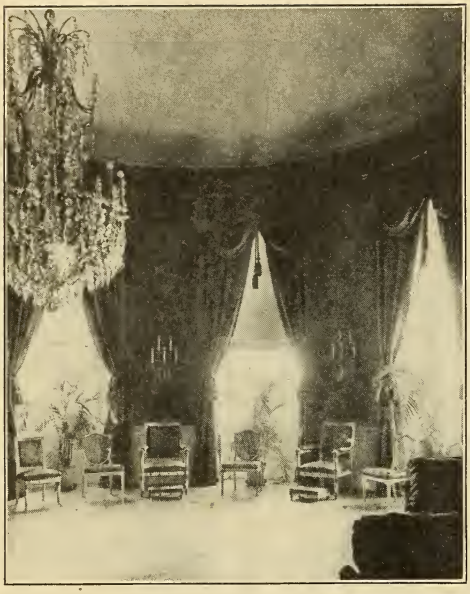
ministration, the White House was reconstructed and enlarged, the electrical equipment underwent a corresponding expansion and transformation. It is now in all respects thoroughly modern and up-to-date. Indeed, the White House might be cited as a Twentieth Century model "electrical residence", for not only is the magic current



FAMOUS EAST ROOM SHOWING ELECTRIC CHANDELIERS



THE STATE DINING ROOM



THE BLUE PARLOR

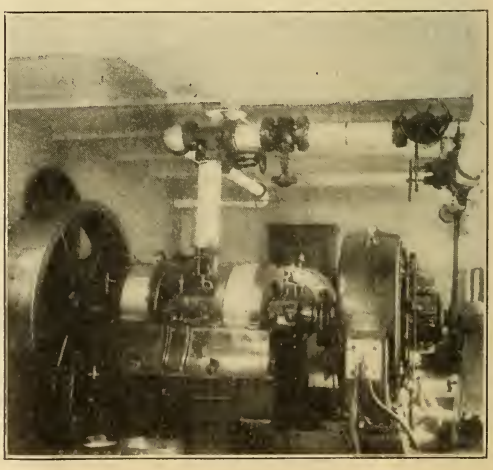
used for a lavish illumination but electricity is employed to operate an automatic elevator and dumb waiters; supplies the energy for a vacuum cleaner for carpets, curtains, etc.; drives upward of two hundred house fans and a number of exhaust fans for ventilating purposes; provides a private telephone system with stations in all parts of the mansion and grounds; and, finally, does much of the cooking in the kitchen and the ironing in the laundry.

The power plant which supplies the electricity for the White House is not located in the mansion but in the sub-basement of the State, War and Navy Department Building directly across the street. The machinery was thus placed because it was not desirable to have the dirt and noise incident to a power plant at the White House and also from considerations of the danger from fire. The power plant has a 200 horse power engine and two Curtis turbines of 75 and 150 kilowatts capacity, respectively. The White House receives a 220-volt direct current for power and a 110-volt direct current for lighting. There is a lighting circuit at the White House stables, located nearly a square from the mansion, and facilities haye lately been installed for the charging of Mrs. Taft's new electric automobile.

As the White House is absolutely dependent upon electricity as an illuminant (the mansion not being supplied with gas), it is of supreme importance that dependable current be available every minute of the twenty-four hours. The equipment in the dynamo room presents three sources of electrical energy any one of which is all-sufficient for White House needs and in the unheard of event that all three installations should be simultaneously out of commission or unable to carry the load from any cause the White House may be immediately thrown on to an emergency street service supplied by the leading commercial company at the national capital.

Although it is a unique thing for a private residence to have an electrician who devotes himself exclusively to its service the electrical expert at the White House is constantly kept busy. The present chief electrician at the Executive Mansion is Mr. George W. Riley, who was for years the chief electrician at the U. S. Military Academy at West Point. He relieved Mr. A. R. Raymond, who had been in charge of the White House electrical department for six years. The White House electrician does not need to concern himself with matters at the power plant, where six electricians are on duty in three shifts of eight hours each. However, the mere maintenance of the White House equipment is a heavy responsibility, the more so because of the fact that all repairs of any magnitude must be postponed until summer, when the President and his family are not occupying the house.

One of the chief duties of the White House electrician is found in the arrangement of

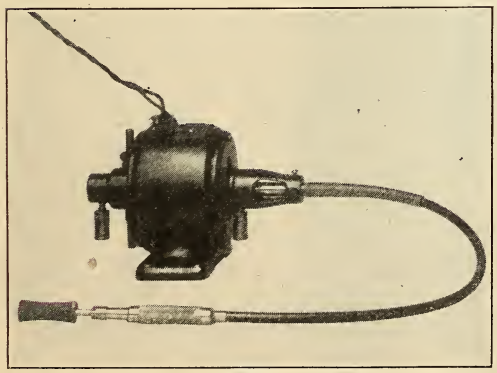


ELECTRIC PLANT OF THE WHITE HOUSE

the special lighting effects for social functions at the Presidential home. Sometimes very elaborate table designs involving the use of numbers of miniature lights are required for the state dinners or banquets at the mansion. The electrician is always on duty until late at night when there is a social entertainment in progress, and often it is necessary or at least desirable that all the wiring and paraphernalia for a special electrical display shall be removed ere the mansion is opened to the public in the morning. The great, ornamental chandeliers which are among the most conspicuous features of the state parlors at the White House—the East, Green, Blue and Red rooms, require much attention. Some of these chandeliers contain hundreds of electric lamps, nestling among thousands of prisms. There are stately electric standards in several of the rooms and simple but impressive electric lanterns in the vestibule and under the porte cochère, just outside the north entrance to the mansion, which is the private entrance for the White House family and their guests.

SHOE TIP BUFFER

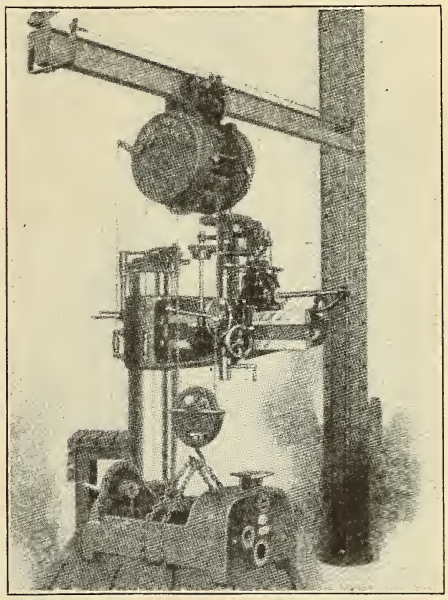
In repairing patent leather shoes and tips an entirely new buffing process is now available in the form of an electric shoe tip buffer. No emery cloth or sandpaper is necessary. It consists of a small electric motor with flexible shaft and buffing tool. In using it there is no possibility of cutting the stitch work.



SHOE TIP BUFFER

ELECTRIC HOIST FOR THE MACHINE SHOP

Time has made great changes in machine shop methods. Principal among these has been the introduction of individual motor drive which does away with the forest of vertical driving belts. But the electrical engineers went one step further and devised ways to handle the heavy castings to and from the machines; result, a small electric hoist which picks the "work" up off the truck as it comes from the car or foundry and swings it over onto the bed of the planer or poises it delicately over the lathe. In the picture one of these little electric lifts, weighing itself no more than 250 pounds, is swinging a heavy casting onto the bed of a vertical boring machine. The lift has a motor operated drum which does the direct lifting and is controlled by the machinist. It is mounted on little wheels which travel the length of the swinging crane arm. It takes but a moment to fasten the chain. Then with a whirr it does its work, raising the casting to a point where it is easily manipulated over the bed plate. This is all accomplished in a small fraction of the time it used to take with a block and tackle.



MACHINE TOOL HOIST

WHAT ELECTRICITY WILL DO FOR THE MODERN FARMER

There are three ways in which the farmer of today may avail himself of the convenience and economy of electricity, and in that respect model his home after that of the city dweller. In many instances he may have a small water power on the farm which at a small outlay could be developed so as to supply electric current for the house, and most of the operations about the buildings which require power. In cases where the farm is near a city or town with an electric light plant, or near an interburban electric railway which makes a practice of supplying current, these sources are available. In the majority of cases, however, the farmer would necessarily need to install a small steam or gasoline driven plant on the premises. This latter undertaking, however, is not nearly as costly as many suppose. The picture herewith illustrates admirably what a progressive farmer may do with electricity. A study of it will create desire on the part of any farmer who takes pride in his property to possess such a plant.

PROPERTIES OF WIRE

Many of the readers of Popular Electricity have asked questions concerning the weights, resistances, etc., of copper and German silver wire. Complete wiring tables are available in most electrical hand books and in the catalogues of wire manufacturers, but these books are not always at hand, so the following tables are printed for ready reference.

Table 1 gives the properties of copper wire. First is given the number of the wire as measured by the Brown & Sharpe standard wire gauge, generally spoken of as the B. & S. gauge. This is the English standard and also the one most commonly used in the United States. The second column gives the diameter of the wire measured in mils, a mil being the thousandth part of an inch. Following this are the weights of the various sizes, per thousand feet and per mile. From these figures it is possible to determine the weight of any given length of any size of wire. The last two columns give the resistances of thousand foot lengths of the various wires, measured in International ohms. The International ohm, by the way, was determined by the delegates of several governments, constituting the International Congress of Electricians. This congress specified that the International ohm shall be represented by the resistance offered to an unvarying electric current by a certain column of mercury at the temperature of melting ice. This column shall weigh exactly 14.4521 grams, shall be of uniform cross sectional area and shall be 106.3 centimeters in height.

In Table 1 it will be noted that the last two columns show the resistance of thousand-foot lengths of wire at 60° F. and 75° F. As copper wire is heated its resist-

Table 2—Carrying Capacity of Wires

	Rubber Insulation	Other Insulation
B. & S. G.	Amperes	Amperes
18	3	5
16	6	8
14	12	16
12	17	23
10	24	32
8	33	46
6	46	65
5	54	77
4	65	92
3	76	110
2	90	131
1	107	156
0	127	185
00	150	220
000	177	262
0000	210	312

TABLE I—PROPERTIES OF COPPER WIRE

English System—Brown & Sharpe Gauge

Numbers	Diameters in mils	Weights		Resistances per 1000 feet in International ohms	
		1000 feet	Mile	At 60° F.	At 75° F.
0 000	460	641	3 382	.048 11	. 049 66
000	410	509	2 687	.060 56	. 062 51
00	365	403	2 129	.076 42	. 078 87
0	325	320	1 688	.096 39	. 099 48
1	289	253	1 335	.121 9	. 125 8
2	258	202	1 064	.152 9	. 157 9
3	229	159	838	.194 1	. 200 4
4	204	126	665	.244 6	. 252 5
5	182	100	529	.307 4	. 317 2
6	162	79	419	.387 9	. 400 4
7	144	63	331	.491	. 506 7
8	128	50	262	.621 4	. 641 3
9	114	39	208	.783 4	. 808 5
10	102	32	166	.978 5	1. 01
11	91	25	132	1.229	1. 269
12	81	20	105	1.552	1. 601
13	72	15.7	83	1.964	2. 027
14	64	12.4	65	2.485	2. 565
15	57	9.8	52	3.133	3. 234
16	51	7.9	42	3.914	4. 04
17	45	6.1	32	5.028	5. 189
18	40	4.8	25.6	6.363	6. 567
19	36	3.9	20.7	7.855	8. 108
20	32	3.1	16.4	9.942	10. 26
21	28.5	2.5	13.	12.53	12. 94
22	25.3	1.9	10.2	15.9	16. 41
23	22.6	1.5	8.2	19.93	20. 57
24	20.1	1.2	6.5	25.2	26. 01
25	17.9	.97	5.1	31.77	32. 79
26	15.9	.77	4.	40.27	41. 56
27	14.2	.61	3.2	50.49	52. 11
28	12.6	.48	2.5	64.13	66. 18
29	11.3	.39	2.	79.73	82. 29
30	10.	.3	1.6	101.8	105. 1
31	8.9	.24	1.27	128.5	132. 7
32	8.	.19	1.02	159.1	164. 2
33	7.1	.15	.81	202.	208. 4
34	6.3	.12	.63	256.5	264. 7
35	5.6	.095	.5	324.6	335. 1
36	5	.076	.4	407.2	420. 3

ance increases slightly as shown by these figures.

When installing systems of wiring it is necessary to know how much current, measured in amperes, a certain size of insulated wire will carry safely. As will be noted in Table 2, rubber insulated wire will not carry safely quite as much current as wires with other insulations.

Table 3—German Silver Wire

Numbers B. & S.G.	Resistance per 1000 feet	
	18 per centum	30 per centum
6	7.20	11.21
7	9.12	14.18
8	11.54	17.95
9	14.55	22.63
10	18.18	28.28
11	22.84	35.53
12	28.81	44.82
13	36.48	56.75
14	46.17	71.82
15	58.21	90.55
16	72.72	113.12
17	93.40	145.29
18	118.20	183.87
19	145.94	227.02
20	184.68	287.28
21	232.92	362.32
22	295.38	459.48
23	370.26	575.96
24	468.18	728.28
25	590.22	918.12
26	748.08	1 163.68
27	937.98	1 459.08
28	1 191.24	1 853.04
29	1 481.22	2 304.12
30	1 891.8	2 942.8
31	2 388.6	3 715.6
32	2 955.6	4 597.6
33	3 751.2	5 835.2
34	4 764.6	7 411.6
35	6 031.8	9 382.8
36	7 565.4	11 768.4

In building rheostats and similar resistance devices German silver wire is often used. Table 3 shows the resistances per thousand feet of various sizes. Eighteen per centum means that there is 18 per cent of nickel in the alloy from which the wire is made, 30 per centum, 30 per cent of nickel.

TREND OF ELECTRICAL DEVELOPMENT

A few years ago every picture of a large factory had to show dense clouds of smoke issuing from great smokestacks and in the foreground had to be a large number of heavily loaded drays hauled by straining horses. All this is archaic now. The up-to-date factory picture shows no black smoke, for such smoke is the height of extravagance and a common nuisance. We have learned that economy and efficiency depend not only upon commercial centralization and co-operative manufacturing and distribution, but also upon co-operative and combined power generation and distribution. The hundreds of teams about the factory yards will some day all be supplanted by electric trucks and factory power be taken from central station wires.

PORTABLE ELECTRIC BUFFER

For polishing automobile parts, brass signs, metal work in offices, hotels and engine rooms, and for innumerable purposes of a similar nature a small buffing machine which can be carried around in the hand will save a great amount of hard labor and produce results that are hard to obtain by the hand scouring process.

An electric portable buffer will do the work with neatness and dispatch. It embodies a

POLISHING METAL SIGN

little $\frac{1}{8}$ horsepower motor with flexible shaft to drive the buffer and a long cord connection to go to the nearest lamp socket. The whole outfit weighs but 27 pounds.

An example of the efficiency of the machine is furnished by its use in a certain large chemical laboratory, where there are 50 or more large copper retorts. Great pride is taken in the brightness of these retorts and it used to take the time of one man for a day to bring one of them up to the proper degree

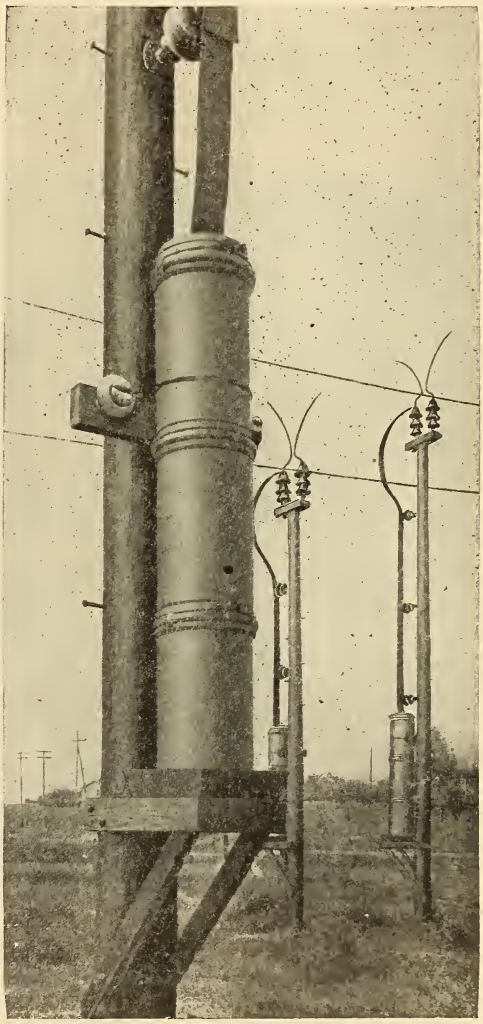
of brightness to suit the exacting taste of the manager. With one of the electric buffers one man is now able to polish 15 to 20 of them in the same length of time.

LIGHTNING PROTECTION FOR TRANSMISSION LINES

The voltage of transmission lines may be from 5,000 to 100,000 volts and the electric current, backed by this enormous pressure, is constantly striving to reach the earth. The ordinary lightning arrester such as might be used on telephone or low tension lines in this case would be useless, for it would offer a weak point in the line where the line current might jump across, form an arc and possibly result in a shut-down of the service. The arrester for high tension lines must therefore present a break of sufficiently high resistance to prevent the escape of the line current, the barrier, however, being such that the lightning stroke, which is of infinitely higher voltage than that of the line, may leap over it or break it down for an instant and pass to the earth.

Among the numerous types of lightning arresters for high tension lines is one which is known as the electrolytic, the operation of which is very interesting. This arrester consists of a number of aluminum trays mounted on a central rod and stacked one above the other as dinner plates might be stacked. These trays are filled with an electrolyte or liquid which forms a very thin film between each pair of plates. The trays are then placed in a cylindrical casing which is filled with oil, and are mounted on a pole as shown in the picture.

One end of the series of trays is connected with the earth. The other end is connected with a heavy metallic strip which leads up to a horn-shaped wire placed close to the line wire. The open space between the horn and the wire is known as the spark gap. Ordinarily the line voltage cannot break down the resistance of the gap and leap across, but when lightning strikes the line the surging which is set up is so powerful that the discharge leaps the gap and passes down into the arrester. Here a peculiar action takes place. The electrolyte, under ordinary voltages is of very high resistance and could not be broken down by the line voltage. But the extremely high voltage of the lightning discharge, which lasts only an instant, punctures the electrolyte in a myriad of places, and for the moment allows the current to flow to earth and relieve the stress on the system. As soon as this is over, the punctures close up and prevents the line voltage, generated by the



ELECTROLYTIC LIGHTNING ARRESTER

distant dynamos, from following up the advantage and forcing current to the earth through an arc of conducting vapor which would be formed in the gap. As a double precaution against the formation of such an arc, the gap is made with two horns, diverging as shown. An arc formed down in the narrow part spreads upward and outward in a fan shape and is eventually "blown out" of itself.

NATIONAL ELECTRIC LIGHT CONVENTION

Furnishing electric current for light and power purposes is one of the greatest industrial undertakings of the age, and it is fitting that all the individual interests which are devoted to the "manufacture" of electricity should have a great and powerful national organization as a medium for the interchange of ideas on the technical and commercial phases of the business. Such an organization is the National Electric Light Association, which has over 3,100 members representing the principal electric lighting companies in the United States. Every year this association holds a convention which is the Mecca of electrical men. There they meet and for a week the men from Seattle and Salt Lake City shake hands with men of Boston and New York and bronzed managers from Texas trade ideas with their friends from Chicago and Minneapolis. Papers treating of the technical features of the equipment are prepared and read by the most prominent electrical engineers in the country. Various phases of the commercial conduct of the business are discussed, and new ways of advertising to the general public the convenience and economy of electricity are propounded. And last, but not least, the electrical manufacturers exhibit the latest appliances which make possible the "wonders of electricity," which we see on every hand.

In all these things a helping hand is held out to the management of the small lighting plant as well as to those who conduct the affairs of the great central stations of the large cities. "We're all in the game to boost," they say. If the man from Texas has found a new way to cool the condensing water for his engines and work an economy in the use of the precious fluid, the men from every dry locality find out about it in short order. How the Middle West Electric Company overcame an adverse public opinion and gained the confidence and enthusiastic support of the community is carefully considered by the east and west and north and south companies.

CONVENTION HALL AT NIGHT—YOUNG'S MILLION DOLLAR PIER, ATLANTIC CITY

This year the annual convention of the Association was held in Atlantic City, N. J. No place is perhaps better fitted for a convention than Atlantic City, for it has the capacity for hundreds of thousands of transients, and a convention crowd which would seriously tax the resources of many cities is hardly noticed in the "Bagdad of the Atlantic."

The convention was held June 1 to 4 and the headquarters were on Young's Million-Dollar Pier.

The great hall which forms the shore end of the pier was a sight long to be remembered, for it is of enormous proportions and electricity was lavishly used in the decorations. The scene was especially beautiful at night, for the pure white light of the tungsten lamps, which replaced every carbon filament lamp in the hall, turned night into day. Ranged around the circumference of the hall were the booths of the exhibitors, all finished in uniform style and with no glaring signs to mar the effect. Sixty-nine manufacturers were represented, and the unique display included almost every electrical device known to the electrical world.

CHANGING ALTERNATING CURRENT TO DIRECT

BY H. L. TRANSTROM.

As an alternating current cannot be put to all the purposes for which direct current can be used, it becomes necessary to use a device to change it as near to direct current

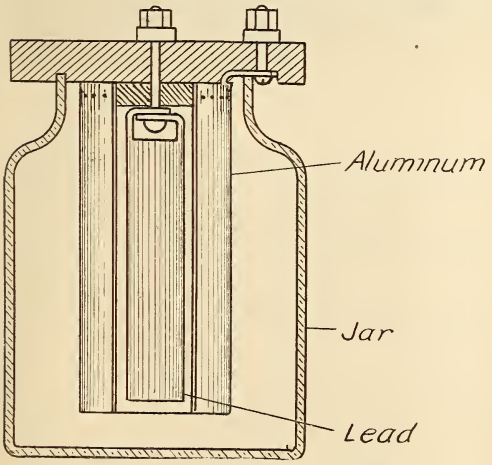


FIG. 1. CHEMICAL RECTIFIER

as possible. The devices that can do this are the motor generator, the mercury arc rectifier and the chemical rectifier.

The motor generator of course gives the best results, but for the amateur experimenter it means a considerable outlay of money and the mercury arc rectifier has the same drawback. Although a chemical

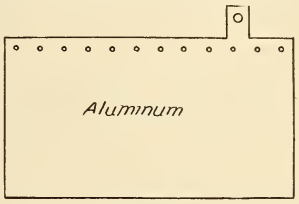


FIG. 2.

rectifier cannot change the alternating current to a direct current suitable for running large motors, yet for charging storage batteries and other uses where it is not absolutely necessary to have a smooth direct current a chemical rectifier fills the require-

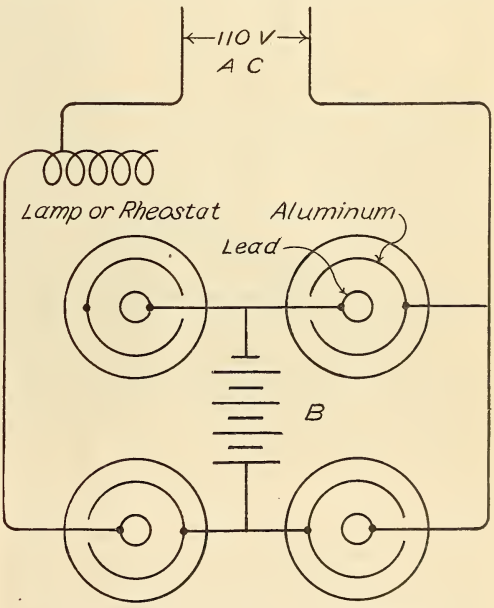


FIG. 3. CONNECTIONS OF RECTIFIER

ments admirably, and it can be made for about $3.00.

Procure four glass jars, those used for ordinary wet cell batteries are well adapted for this purpose, although any glass, rubber or porcelain jar will do. Cut four disks of dry birch to fit loosely in the tops of the jars, and four more disks four inches in diameter by ½ inch thick. Screw the latter fast to the smaller disks to form covers for the jars.

Cut a one-inch lead water pipe into four six-inch lengths and cut out of each with a

hack saw enough to be able to bend the top together in such a manner that a long machine screw can be passed through it to a binding post on top of the cover (see Fig. 1).

Cut four rectangles of soft aluminum six by five inches by $\frac{1}{8}$ inch thick, with a projection $\frac{3}{4}$ inches long and $\frac{1}{2}$ inch wide, as shown in Fig. 2, which is bent over at right angles. Screw these plates fast to the $\frac{1}{2}$ inch disk, concentrically with the lead pipe, and countersink the projection into the wood so that it is flush with the under side of the four-inch disk. Bore a hole through the projection and the disk and fasten a machine screw through it to the binding post.

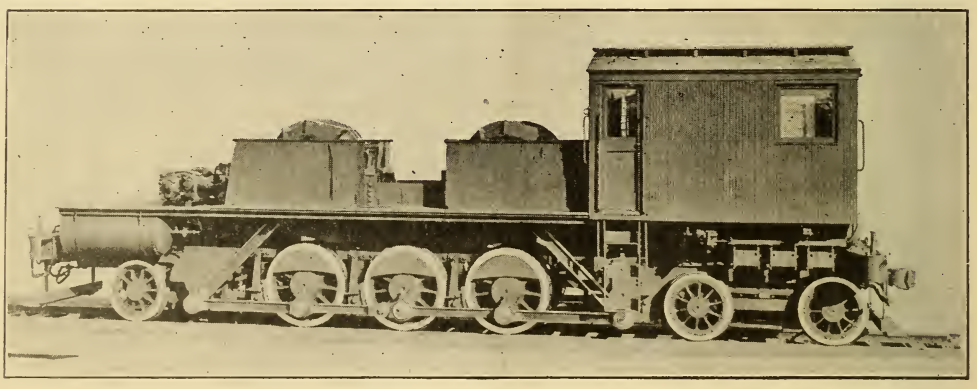
When the four jars are complete fill a larger jar with enough cold water to fill the smaller jars about three-quarters full. Into the cold water pour one pound of pure ammonium phosphate and stir until it is all dissolved.

Do not mix the solutions separately, as they are likely to be of different strengths.

The rectifier is now complete, but it remains to be connected up properly as shown in Fig. 3. A rheostat should be used in series with the alternating current and the rectifier. For purposes requiring little current a 16 candlepower lamp can be used as a rheostat.

In Fig. 3 the rectifier is shown as charging a small battery (B). The battery may, however, be replaced by any small current consuming device requiring direct current. With 110 volts alternating current sent into the rectifier direct current of about 80 or 90 volts is obtained.

A NOVEL ELECTRIC LOCOMOTIVE



ELECTRIC LOCOMOTIVE WITH SIDE ROD DRIVE

When the electric locomotive first came into use it apparently possessed a great advantage over the steam locomotive in one important particular, namely, there were no massive connecting rods for the propulsion of the drive wheels, the motors driving the wheels direct. This obviated the loss of power due to rapidly reciprocating these heavy masses of steel. But in developing new ideas there is often a tendency to revert to old and tried methods, so after a time designers began to wonder if the old side rod principle might not possess advantages in electrical operation. So they tried the scheme and the locomotive shown in the picture is the result. Its practical value will of course need to be demonstrated by much experiment and many hard knocks.

The advantages claimed for the new type are as follows: Since the motor need not be mounted on the axle, more space is available and it may be built of large diameter and embody other features which will give it greater efficiency. It may also be supported by springs, reducing the jar and rendering it longer lived. Two such motors on a locomotive may be made to do the work of four necessary on other types, securing economy of construction and reducing the cost of the locomotive. The motors in such a locomotive can be located so as to concentrate a greater proportion of the

weight near the center of the machine with the attendant advantage that the "moment of inertia" of the locomotive around its vertical axis will be as small as possible. This will reduce the rail pressures at the leading and trailing wheels and, consequently, the flange and rail-head wear. The location of the motors in the cab facilitates inspection and repairs and the renewal of brushes. The maintenance charges for the motors will also be greatly reduced as practically all road dust and other injurious foreign material can be kept out of the motors.

EVERY MAN AN ELECTRIC RUNABOUT

BY AGNES DEANS CAMERON

You are your own voltaic battery. Every man is an electric runabout. So says Dr. Andrew McConnell, president of the Society of Universal Science, who is himself electrifying New York and Boston with the basic theory that the life principle of man is no mystic fluid, but electricity pure and simple.

Discrediting the idea that we live and move and have our being through some mysterious life force breathed into us at birth and withdrawn at death, Dr. McConnell, a southern scientist, declares that the life energy is electricity generated within our bodies, applied and controlled by our wills.

DR. ANDREW MCCONNELL

What great advantage would there be in finding this true? It would bring all the laws of life under the workings of the well-known laws of electricity. Every man becomes at the same time his electric motor, his own electrical engineer.

For over a decade Dr. McConnell has devoted himself to medical-electro experimental research, with the result that he builds up these three hypotheses:

1. Life power is electricity and is therefore directed and controlled by the laws of electricity.

2. The amount of electricity in each man is the measure of that man's health and working power.

3. This life electricity can be increased at will and to any extent by the individual, and so health and long life are easily within the reach of every human being.

These contentions open up a fascinating field of thought. Especially in the realm of electricity does the wise man hesitate to say, "This is impossible," "That is absurd." The Unknown of today is the Known of tomorrow. A Franklin told us that there is electricity in the air, it took a Marconi to demonstrate that this air-electricity can carry wireless messages. A Galvani told us a century ago that there is electricity in every living creature. May it not be an Andrew McConnell who shall establish the fact that we can at once make, control, and apply that life-stream?

If Andrew McConnell can teach us how to turn on the electric current and charge our batteries—we already know that electricity can decompose anything — it would appear that all we will have to do, to keep our bodily organs at their highest efficiency, will be to make proper application of this dormant force.

Dr. McConnell disclaims having discovered much that is original, but to have assembled a mass of proof from the experiments of others and linked his findings together in a chain of scientific reasoning to substantiate his theory. Here are some of his reasonings:

Every schoolboy knows of the experiment by means of which Galvani touched a dead frog to an electric machine and saw the muscles move as in life. Since Galvani's time numerous experiments have demonstrated that electricity contracts muscles. It is the electrical contraction of muscles which produces all movements of the body.

Acids and alkalies cannot come together in a moist state without generating electricity. It is the union of the stomach acids and the alkalies of the saliva which makes the electricity that dissolves our food in the stomach; the stomach itself is a voltaic

battery. When we say facetiously that certain hearts are reached through the stomach, we in a half-hearted way feebly state a psychological and electrical truth. Dr. McConnell maintains that we should be able to direct a current of bodily electricity to our stomach battery and so set the process of digestion merrily on its way. It is said that most of modern man's physical ailments proceed from faulty digestion. Make a man absolute monarch of his stomach and he can master his enemies and dominate his destiny. It is dyspepsia that makes suicides, curdles the milk of human kindness, and allows divorce-lawyers to buy big automobiles. Give the man with the undertaker face and the rabbit-skin chest-protector the secret of sending health-giving electric currents into his little digestive system and his dog will come out from hiding under the woodshed, his wife smile as she used to 20 years ago.

What part does the brain take in all this? Professor Munsterberg, of Harvard, demonstrates very clearly that the brain is an electric battery of the most potent and sensitive type; that it both receives and transmits electric thought-currents.

According to the fascinating McConnell theory each one of us is a moving voltaic battery, insulated by our skin, hair, nails, and the texture of our clothing; each organ within us is itself a complete electric battery, and all the life processes electrical. The expansion of the lungs and the separation of the oxygen from the air, the whole process of digestion, the heart action, the formation and chemical changes in the cells, the secretions of liver and kidneys, the five senses of smell, taste, sight, hearing, and touch, in fact every process essential to life is a simple electrical function.

Most men think themselves more vital than a fish, yet there are many varieties of fish which give electric shocks, give them when they want to, and direct them where they will. It is not a very up-to-date man who is willing to take second place to the thunder-fish of the Nile, the torpedo-fish of the Mediterranean, or the electric eel of South American rivers. A one-horse man is a poor specimen. An historic American in the midst of a hot political campaign was glowingly characterized as "a whole team and a dog under the wagon"; yet with the power of a few electric eels at his disposal, properly directed, he would be this and more.

It would be a poor-spirited "human," Dr. McConnell says, who would refuse to take hold and run the machine when a scientist tells him that, without knowing it, he is the owner of a great splendid touring-car more delicately adjusted, more potent than the shiny and expensive one that whizzes along the city boulevards.

VENTILATION.

Ideal ventilation can only be obtained by the use of some system which will draw the pure, outside air into the room, thereby

NEW ELECTRICALLY OPERATED VENTILATOR

forcing the vitiated air out, and at the same time not permitting the inflowing air to strike the occupants of the room directly. These conditions are not fulfilled by an open window, even if it be opened at the top, for the cold air in that case simply comes in at the top and drops, by reason of its greater density, upon the heads of the occupants.

A very simple mechanical ventilator which gives the proper distribution of pure air in the room is shown herewith. It consists of a casing with an electric driven centrifugal fan located within. An air duct from the back of the casing is led out into the open air. In the front is a grating pointing upward. The rapidly moving fan inside draws in the pure air through the duct and then forces it out through the grating in a stream toward the ceiling, the force being sufficient to carry the air to all the upper portions of the room from whence it gradually settles, driving out the impure air at the bottom.

To take the chill from the incoming air, in the winter time, a system of steam radiating coils is placed in the casing which is fed from the pipes of the steam heating system.

PROPER METHODS OF TYING AND SPLICING WIRES

As the sailor has his standard kinds of knots, which have been tied just so for generations back, so the electric lineman is supposed to make the ordinary ties and splices of the overhead wires in certain ways, specified by standard usage, if he does not want to call down upon his head the imprecations of the line foreman or the derision of his fellow workers. Some of the ties and splices which have become standard practice and which are approved by the National Electric Light Association, are shown in the diagrams.

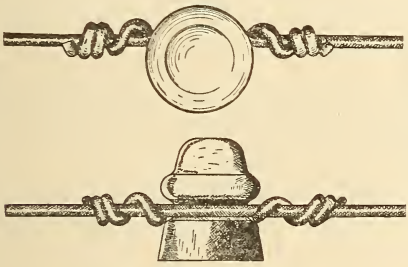


FIG. 1. SINGLE TIE

Fig. 1 shows the top and side views of an insulator to which the line wire is attached by what is known as the "single tie." It is made by taking a piece of wire about 12 inches long and bending it around the insulator under the line wire and making two or three wraps on each side. The ends of the tie wire should always be cut off close to the line wire.

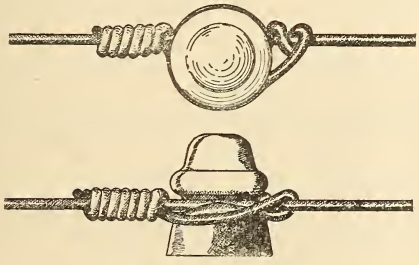


FIG. 2. BACK TIE

The "back tie" is shown in Fig. 2. A piece of wire about 18 inches long is bent around the insulator under the line wire, with four inches of tie on one side of the insulator and the remainder on the other. Then wrap the short end three times around the line wire, leaving a space equal to the diameter of the wire between each of the wraps. Then take the long end, wind it closely around the line wire two times, bring it back around the insulator and wrap three times around the line wire between the turns of the short end. Cut off close to the line wire.

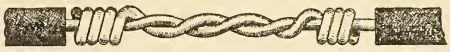


FIG. 3. COMMON SPLICE

An ordinary splice for two wires is shown in Fig. 3. The two ends to be spliced are scraped perfectly clean and free from insulation. They are first given a complete long

FIG. 4. TAP FROM MAIN LINE

wrap and then the two ends are given four complete short wraps. The joint is then cleansed with standard soldering compound and well soldered with pure half-and-half solder. Finally the joint is taped.

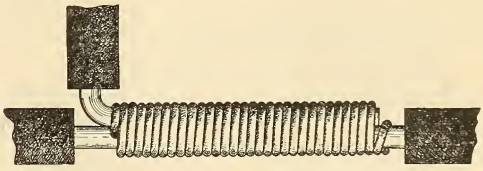


FIG. 5. TAP FOR HEAVY WIRES

A tap is taken off from a main wire as shown in Fig. 4, if the wires are comparatively small. For heavy wires the method shown in Fig. 5 is employed, in which the wires are bound together with a closely wrapped layer of No. 12 copper wire. In each case the joint is soldered and taped.

During the last six months 195 new electric lighting companies have been formed in the United States and 20 in Canada and Mexico. The present total for the United States is 5264 companies and 5740 including Canada, Mexico and the West Indies. These figures show a total gain of 276 plants over the corresponding figures of a year ago.

POPULAR ELECTRICITY WIRELESS CLUB

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine is devoted to the interests of the Club and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments.

SPARK COIL CONSTRUCTION AND OPERATION

BY VICTOR H. LAUGHTER.

PART IV.

DIMENSIONS OF VARIOUS COILS.

Dimensions of various sizes of spark coils are given below. If the amateur prefers to construct a larger or smaller coil than the four-inch size described in this series, he can take the dimensions from the table and proceed with the construction on the same general plan. However, if the coil in view is to be larger than the four-inch size slightly different rules should be observed in the construction.

DIMENSIONS OF COILS FROM 1 TO 20 INCHES

A	1 inch	2 inch	3 inch	6 inch	8 inch	10 inch	12 inch	14 inch	16 inch	18 inch	20 inch
A	7½ inch	9½ inch	11½ inch	14 inch	17 inch	17 inch	18 inch	18 inch	19 inch	20 inch	20 inch
B	1 "	1 "	1½ "	1½ "	1½ "	1½ "	1⅝ "	1⅝ "	1¾ "	2 "	2 "
C	No. 18	No. 16	No. 14	No. 12	No. 12	No. 12	No. 12	No. 12	No. 12	No 12	No 12
D	1½ inch	1 5-16 inch	1⅞ inch	1⅞ inch	2 inch	2 inch	2⅛ inch	2⅛ inch	2¼ inch	2½ inch	2½ inch
E	3½ "	1¾ "	2¼ "	2¼ "	2½ "	2½ "	2⅜ "	2⅜ "	2¾ "	3¼ "	3¼ "
F	5½ "	3½ "	4 "	4½ "	6¼ "	6¼ "	6½ "	7 "	7 to 8 "	8 to 9 "	9 to 9½ "
G	5½ "	8 "	9½ "	10 "	11 "	11¼ "	14 "	14½ "	15¾ "	16 "	16 "
H	4	6	8 "	30	36	40	40 "	46	50	50	60
I	1 lb.	2 lbs.	3 lbs.	7½ lbs.	8 lbs.	10½ lbs.	12 lbs.	14½ lbs.	16 lbs.	18 lbs.	22 lbs.
J	1000	2000	2400	4500	8300	8500	10,000	12,500	14,000	20,000	24,000

A—Length of core.
B—Diameter of core.
C—Gauge of primary wire.
D—Internal diameter of insulating tube.
E—External diameter of insulating tube.
F—Approximate diameter of secondary winding.
G—Distance between coil heads.
H—Number of sections in secondary.
I—Quantity of secondary wire.
J—Total number of square inches of foil.

From what has been previously learned, we know that the greatest difference of potential, or electrical pressure of an induction coil is between the ends of the secondary where the induced current flows up to the secondary terminals. Since the iron core is in near proximity to the point of the greatest difference of potential, being separated from it by only the insulating tube, and if the coil is of the larger size, a "breakdown" will sometimes occur due to the current breaking across to the ends of the iron core. The iron core offers a more conductive path than the leads to the secondary terminals. To obviate this difficulty the secondary in the larger sizes is wound with the greater portion of wire in the central sections. This is made clear by reference to Fig. 16. The central hole of the end sections is increased in diameter and the space between this central hole and insulating tube is filled with an insulating substance, usually paraffine wax. The exact proportion of the end sections to the central sections is of only minor consideration. This plan, as stated, need not be followed unless the coil is larger than the four-inch size.

An apparent discrepancy exists in the dimensions given below. As noted the dimensions for a three-inch coil gives the core as 11½ inches in length, while in the dimensions for the four-inch coil previously described the core length is 10 inches. This difference in length, however, is made up for in the general construction.

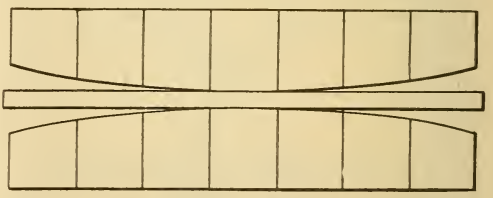


FIG. 16. METHOD OF WINDING SECTIONS OF LARGE COIL

SPARK COIL EXPERIMENTS.

Experiments which can be carried out with the sparks coil are beautiful in effects

NOTE: In Chapter II, page 106, the first section of the coil should be wound with five ounces of wire instead of three ounces, as stated.

and surprising in results. No other electrical instrument offers as wide and varied a field for experimental work. With it X-Ray photographs can be made of the various portions of the body, bringing out in clear relief the interior parts which are concealed to the naked eye. It can be connected up for use in wireless telegraphy and messages sent through the ether, the distance dependent on the size of coil used. Among numerous other experiments may be mentioned the lighting up of Geissler tubes and the taking of electrical photographs, this last named showing the most beautiful application of the coil.

Operation of the coil will first be described connected up for use in a 20 mile wireless set. In making the statement, however, that this coil will work over a distance of 20 miles, it must be understood that it will do so under the best of conditions. In addition to the coil will be needed six one-pint Leyden jars, zinc spark gap, tuning helix and sufficient flexible conducting cord to make the various leads.

The Leyden jar can be purchased complete if so desired, but as the price is usually $1.00 or more the amateur may prefer to build it himself. The construction is simple. First, get six one-pint chemical beakers from any druggist or chemical supply house, and about one pound of tin foil. Cut the tin foil in strips of sufficient length to reach around one-half of the circumference of the jar, and three-fourths of the total height. Coat one side of the foil strip with library paste and place it down in the jar so that it clings neatly to the interior surface, and rub it down with a flannel rag until it adheres closely to the jar and all uneven places have been rubbed out. The opposite half is covered in this manner.

A disk is next cut of a size corresponding to the size of the inside of the bottom of the jar. Then carefully coat one side of this disk with the paste and drop in the bottom of the jar, rubbing it down the same as for the sides, and using care to make the edges of the foil come in contact with the side pieces. The outside of the jar is then coated in the same manner.

The exposed glass portion of the jar should be well coated with shellac to prevent leakage of the current.

A contact is now provided to make connection with the inner coating of the foil. A very simple method is to cut a 1-16-inch brass rod of sufficient length to clear the top of the jar two inches when resting on the bottom. On the end of this rod is preferably soldered a small round brass ball such as used for the hammer of an electric bell. This ball, owing to its shape, will prevent leakage of the stored charge, and unless it is used, there will always be a certain amount of leakage from the end points. To hold the rod in the jar cut two pasteboard disks, one to rest about one inch clear of the bottom, and the other about one inch from the top. Holes are punched in the center of the disks for the insertion of the rods. On the inside bottom of the jar a few scrap pieces of tin foil should be placed, so that the rod will make good contact and not scratch the foil surface. When the rod has been placed in the upper disk, the latter should be well coated with shellac, which will hold it in place better, and give more perfect insulation. This completes work on the Leyden jar and it is evident that the remaining five are constructed in the same manner. It is not essential, however, that chemical beakers be used for any other type of thin, high grade glass jar will answer. The jars are then connected to the other apparatus as shown in Fig. 17.

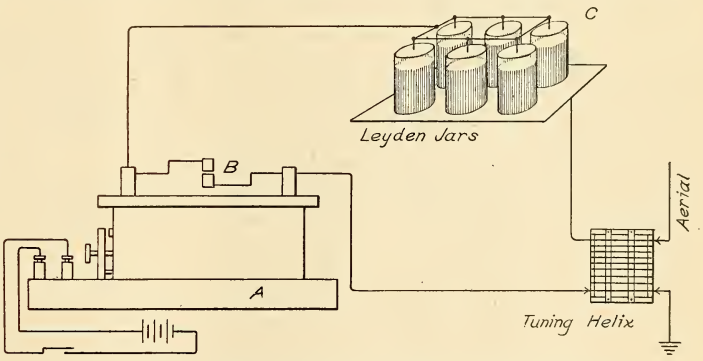


FIG. 17. CONNECTIONS OF THE LEYDEN JARS

The complete spark gap (B) of Fig. 17 is illustrated in detail in Fig. 18. It consists of the hard rubber base (F) with the binding posts (AA) mounted on it, and through the binding posts is run the brass

arms (CC) with the zincs (DD) mounted on the ends, and on the opposite ends are mounted ebonite handles (EE).

The hard rubber base measures four inches long, two inches wide and $\frac{3}{8}$ inch thick. Holes are drilled and countersunk in the center one inch from each end. The

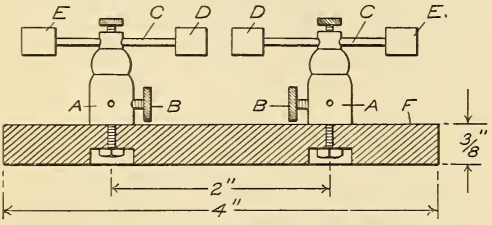


FIG. 18. COMPLETE SPARK GAP

binding posts are illustrated at (AA). These binding posts should be of sufficient height to hold the spark gap at least one inch above the base when mounted. The exact style of binding posts to use makes no difference, but it is best to select a type with a second lead as shown at (B), so that connection can be made with the secondary terminals of the coil, and to the leads to the condenser and helix.

The zincs can be cut from the rounded end of a battery zinc. Cut $\frac{1}{2}$ inch long and drill a 1-16-inch hole $\frac{1}{4}$ inch deep in the end of each. The brass rods (CC) should measure approximately 1-16 inch in diameter and two inches long. The ebonite handles (EE) come in stock sizes and can be bought at any electrical supply house. Shove the ends of the rods in the zincs and mount as shown. The faces of the zincs should be well polished with emery cloth before mounting. This completes work on the spark gap. The constructor can of course improve on the type of gap shown here, if he so desires, but this type will meet the requirements in view.

The parts which go to make up the helix are as follows: Two oak disks $\frac{1}{2}$ inch thick and six inches in diameter; eight wood standards one inch square and six inches high; 10 feet of No. 8 bare copper wire. The edges of the disks are countersunk, at equal distances around the entire circumference with one-inch squares as shown in Fig. 19. The wood standards are now cut with V-shaped notches $\frac{1}{4}$ inch deep and one inch apart all the way down. Holes are drilled at each end. The completed piece is shown at (A) in Fig. 19. The wood standards are now screwed to the disks in the countersunk slots.

The frame is now given several coats of shellac, and when dry the No. 8 wire is wound on. Begin by first screwing a binding post to one of the pieces near the top The hole in this binding post should be drilled out large enough to allow the insertion of a No. 8 wire. Lock the upper end of the wire in the binding post and wind around the frame, placing the wire in the notch of each piece and coming one notch lower at each turn. The lower end of the winding should be locked in a binding post the same as for the upper end. The completed helix is shown in Fig 20.

The various parts are now complete and the set is ready to be connected up for use.

The spark gap can be mounted on top of the coil case between the secondary ter-

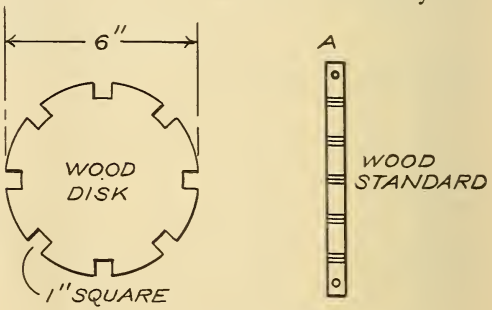


FIG. 19. SENDING HELIX PARTS

minals as shown at (B) Fig. 17. Although some experimenters prefer to mount the gap at other points, this is only a matter of choice. The Leyden jars are best mounted by first placing down a pane of glass, and

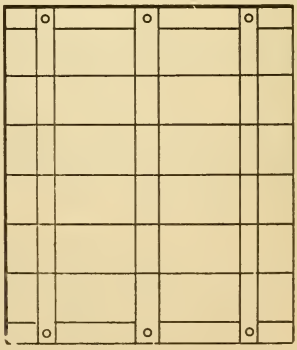


FIG. 20. COMPLETE HELIX

on this a thin copper sheet; the jars are set on the sheet so that it will make a contact with the outside coating of each jar.

The rods which make connections with the inside coating of the jars are now soldered together by one common wire, and a leap made of flexible lamp cord is carried back to one of the secondary terminals.

vantage, however, of retaining the photograph for future use. To view an object when the fluoroscope is used, it is only necessary to hold the desired object between the X-ray tube and the fluoroscope. The mak-

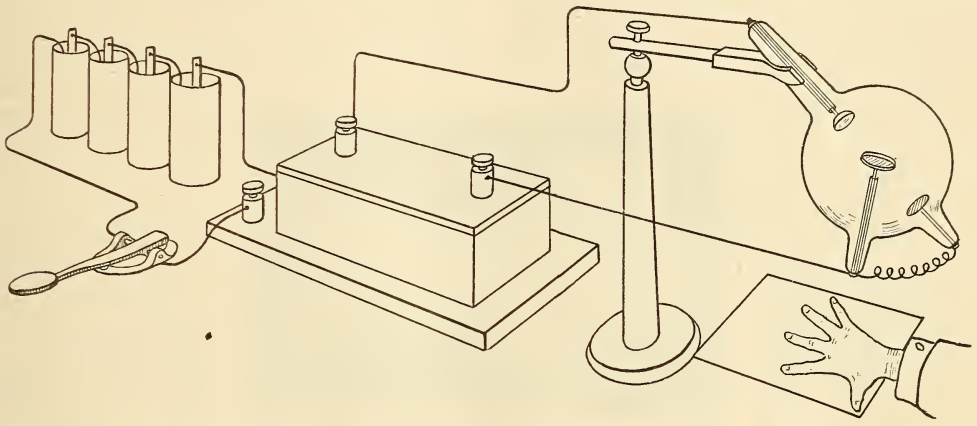


FIG. 21. USING COIL FOR TAKING X-RAY PICTURES

A second flexible lead is soldered to the copper sheet, with a metallic clip soldered to the opposite end, so that connection can be made instantly with the different turns of the helix. The next lead runs from the remaining secondary terminal over to the helix as shown.

The ground wire may be soldered onto the lower turn of the helix, but the aerial should be a variable contact.

It is evident that the amateur can add improvements to the general constructional plan as described here, as the various parts have been described in as simple manner as possible, so that the uninitiated will have no difficulty in following the principles of the construction.

RADIOGRAPHS.

Radiographs or X-Ray photographs can be very easily and successfully made with this coil. In buying the X-ray tube the constructor should state the size coil he is using, as tubes vary to a large extent for use in connection with different size coils. The average price of such tubes ranges from six to eight dollars, depending on the quality. It is also advisable to purchase a fluoroscope, as with it, the bones of the hand, the interior of a purse and other objects will be made visible to the naked eye. Without the fluoroscope it will be necessary to take the image on a photographic plate, and develop the plate to bring the object to view. This latter method has the ad-

ing of radiographs, however, is a more difficult operation.

The complete X-ray set connected up for use is shown in Fig. 21. An ordinary photographic plate is placed below the tube at a distance from three to six inches with the sensitive side upwards. Place the hand on the plate, considering that a radiograph of the hand is to be made, and start the coil in operation by closing the battery switch. If the tube lights up with a greenish hue, it is working at full value and a clear radiograph should be the result. Make several exposures with different objects, at the same time varying the position of the tube and the distance of the object from the tube. In this manner the experimenter will soon be able to determine the exact position necessary for the best results. This must of course be done in a dark room or with the photograph plate carefully wrapped in black paper.

ELECTRICAL PHOTOGRAPHS.

The making of electrical photographs is a simple operation and does not require a large size coil. The photographs shown herewith were all made with a one-inch coil, and with the larger size much more elaborate effects can be obtained.

Considering that the coil is at hand the only other requisites needed are a can of talcum powder, a copper or brass sheet measuring about six inches square, and a number of photographic dry plates.

Connect one of the terminals of the spark coil to the metal sheet and solder the other terminal to a needle.

One of the plates is now taken from the box and laid on the metal sheet with the sensitive film surface upward. The plates should only be taken out of the box in a well darkened room, and preferably the photographs should be made at night, for this will lessen the danger of any stray beams of light affecting the sensitive film. A small photographer's ruby lamp should be in the room so that sufficient light will be had to show which side of the plate the film is on. The film side can be easily recognized as it has a dull, rough finish.

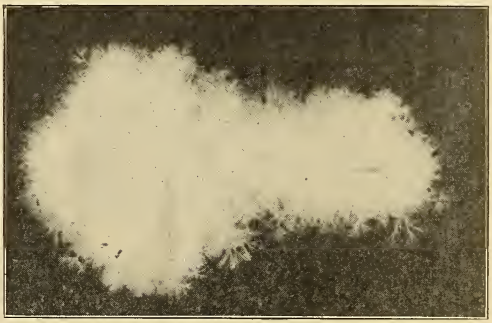


FIG. 22. PHOTOGRAPH OF KEY

Lay the plate on the metal sheet as before mentioned and place the second contact with the needle point in the center. A thin film of talcum powder is next sifted over the surface.

The key of the coil is now pressed for about a second. This will cause a spark to appear at the needle contact and spread over the surface of the plate. The plate is now taken up and wiped carefully with cotton batting and placed in a box and is later on developed, which brings out clearly the features of the sparks. Photographs of metal objects can be made by placing

FIG. 23. PHOTOGRAPH WITH NEEDLE POINT ON PLATE

FIG. 25. PHOTOGRAPH OF BUNCH OF KEYS

FIG. 24. POSITIVE POLE CONNECTED TO NEEDLE

FIG. 26. PHOTOGRAPH WITH THE SECONDARY LEADS ON PLATE

the object on the plate and making contact with the needle point.

In Fig. 22 is shown the photograph of a Yale key made in this manner. In Fig. 23 is shown a photograph made with the needle point resting on the plate. The needle point was in this instance connected to the negative pole. Fig. 24 is from a photograph made with the positive pole connected to the needle. As noted the positive pole gives a flaming spark resembling a fire ball. Fig. 25 was made by laying a bunch of keys on the plate. The photograph in Fig. 26 shows a very curious effect. This was made by placing the two secondary leads on the plate. By close examination it will be seen that the film of talcum powder was driven from the right to the left hand side.

The experimenter can of course vary the range of his experiments a hundred fold and produce various effects.

(The End.)

ELECTROLYTIC INTERRUPTER

The question is often asked: How can I operate my spark coil from the ordinary lighting current? The solution of the problem is to use an electrolytic interrupter. Such an interrupter is shown in Fig. 1, and it may be connected in series with any ordinary spark coil and the 110 or 220 volt direct or alternating current lighting circuit. No

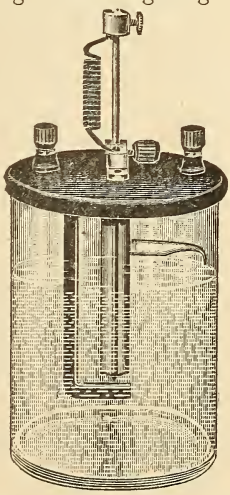


FIG. 1. ELECTROLYTIC INTERRUPTER

resistance or condenser is used, the vibrator of the coil must also be screwed up tight as it should not vibrate when the interrupter is in the circuit, as the latter does the making and breaking.

The interrupter starts with 50 volts. A metal rod of especial alloy goes through the cover, down into the glass tube. This tube at its lower end has a peculiar aperture in which the point of the rod fits. The tube at the upper end has a screw top which screws in the cover. This tube is made of special material and will not crack even if the interrupter is worked steadily. In operation the metal rod wears itself away to a point. The rod itself is fed down by gravity. This action is entirely controlled by the weight attached to the top of the rod. In fact the entire success of this interrupter lies in the right weight of the metal.

FIG. 2.

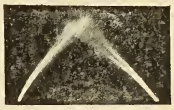


FIG. 3.

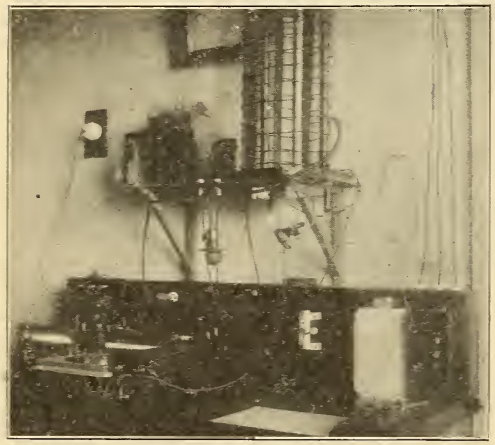
Too much weight gives no spark at all, too little gives an uneven and unsteady spark. Very little metal is used up; it takes about 60 hours' constant work to consume one inch of the rod. The rod can be left constantly in the solution without harm.

Use of the interrupter also increases the power of the spark, and with a one-inch coil connected to the proper condenser, and a zinc spark gap properly adjusted, you will get a crash that will almost take your breath away. To illustrate this Figs. 2 and 3 show two discharges from the same coil, using 110 volt current. In Fig. 2 the interrupter was not used and the spark is stringy. In Fig. 3 it was used and the spark was much better. As will be noted, the flame shoots upward due to the great amount of heat raised.

The opinion recently expressed by a French naval surgeon that the electric waves used in radio-telegraphy endangered the eyes of operators is pronounced unfounded by Mr. Marconi. He says that no case of this kind has occurred among the employees of his company, and no others have come to his notice. Besides, Mr. Marconi has had a particularly good chance to test the matter himself at his stations for trans-Atlantic service. At these places much more powerful apparatus is used than on shipboard, and he has worked with it for hours at a time, repeatedly, without the slightest ill effect.

WHAT A CLUB MEMBER IS DOING

One of the members of Popular Electricity Wireless Club has designed and built almost entirely by his own efforts a wireless station in which he takes considerable just pride. George D. Henderson is his name, and he lives at 2827 Southport Ave., North Edgewater, Chicago. He sends us a photograph of his equipment which we reproduce herewith as an inspiration to other mem-



INTERESTING AMATEUR EQUIPMENT

bers of the club who are building wireless equipments for another purpose than to simply hear the sparks crackle. With this equipment he is able to send and receive messages to and from the steamers on Lake Michigan and the numerous wireless stations in the city.

The sending apparatus consists of a one-quarter kilowatt transformer, operated from the electric light current; sending helix, consisting of a wooden frame 14 inches by 12 inches wound with 25 feet of No. 8 bare copper wire; a spark gap of brass rods with zinc tips, and a large condenser of six plates 8 by 10 inches with tinfoil five by six inches. The sending instruments are connected up according to De Forest's plan.

The receiving apparatus consists of a tuning coil having 372 meters wave length; 300 ohm potentiometer; five detectors, silicon, electrolytic, microphone, carborundum, and molybdenite, a variable condenser; fixed condenser; 1000 ohm receiver and battery, and also a five-point switch by which any of the five detectors can be thrown in circuit. These instruments were all home made except the silicon detector, telephone, sending key and switches.

A filings coherer is also used in connection with a 100 ohm relay and tapper, for signaling.

The aerial consists of six No. 15 bare copper wires, each 40 feet long, spread a foot apart on spreaders five feet long. The height is 45 feet.

THE WIRELESS MANIA

A most horrible state of affairs exists in Philadelphia, a city in which brotherly love is supposed to predominate. One of its citizens seems to think so at least, and it is all on account of wireless. So he wrote to a prominent wireless telegraph engineer for expert advice; and here is his letter:

In our city here, unfortunately for the welfare of some of our citizens, a tower exists about 525 feet high above the street level; a very fine place to send out deadly electric waves from the wireless telephone or the wireless telegraph apparatus; the latter of which they are now installing to work from our City Hall tower. Now I have been bothered for months, night and day, by deadly electric waves being trained on me and my home, and also on my mother, who is a woman over seventy years of age.

"I have been shocked almost to death several times by wireless electric waves and have had other dirty work done on me unfit to write. This wireless apparatus is trained on me now while I am writing this letter, and has been trained on me all day. I am almost positive that this dirty work is done on me from our City Hall, by the Republican Party that is in power in this city. We have a bad administration here and they have been denounced as thieves in public print here.

I am a steam engineer and have had some electric experience with dynamos up to 2,500 volts and have been reading up wireless now and then for the last six months.

My house is only a two-story affair, about 23 feet from the ground to the roof, not much height for wireless.

As I believe that you are well versed on wireless, what would you think best for a fellow to do in such a case? I went to a couple of lawyers, but that did not stop it. I reported the case to the United States Government at Washington and still it is trained on the house.

A fellow has a job to get any rest with a machine like that buzzing on your ears and vibrating on your brains all night.

The wireless telegraph engineer felt that he ought to answer this appeal, but as the technical points involved were too deep even for a brain steeped in wireless knowledge, he decided to put his answer in the form of a sort of fairy story, better tuned, as he thought, to the receiving apparatus of his Philadelphia correspondent. So he answered as follows:

Your highly interesting letter received today. It is indeed a great shame that the wireless station has been placed so near your house. This is contrary to the Jeffersonian Democracy and the Declaration of Independence, and you, as a free born American citizen, should fight it from beginning to end.

In my long experience in the wireless field, and voting the democratic ticket, I have never known of such a case of republican extortion. They are trying to force you to vote their ticket. Don't do it. Insulate your body as I will explain to you later on, and then you can bask in the deadly electric waves with impunity. In fact, the waves will give you a vigor and feeling that you have never had before.

Ah! if you could only do as the cannibals of the Bazoo Islands did to a naval wireless expert some time ago. The navy erected a high power station on the Isle of Bazoo. This island was dry and sandy and the natives, owing to the non-conductive influence of the ultra violet rays would often feel a faint tingling sensation. They instantly knew what it was. It was caused by the naval expert pressing the key which turned loose several million volts on their island. All the vegetation was shrinking up and drying. But the climax came.

One day the ill-fated King Cephas of Bazoo was walking down the beach when a flash of lightning from the top of the wire that sticks up in the air, sprang down, hit him between the shoulders, and he fell over stone dead.

The natives knew the reason. They instantly made soup out of the wireless expert and are now wearing the Leyden jars for watch charms.

This was caused by the enormous voltage becoming stored up in the air and ground and making a discharge like lightning. This will always happen around a high power wireless station. The Philadelphia station will no doubt have a like discharge at an early date which will tear down buildings and possibly injure a few people.

The best way to protect yourself would be to wear a feather duster, which are worn by all wireless operators. I will tell the secret of how it is made to you, but be sure to keep it confidential, for only a few of us know. First take a common linen duster and soak it in LaPage's glue. Now put the duster on and cut open a feather bed and roll in it for about fifteen minutes. Be sure that feathers adhere to all parts of the duster.

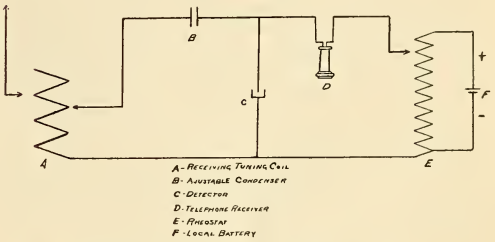
The above duster is a practical guarantee against the wireless waves. You need have no fear while wearing it.

CONSTRUCTION AND ADJUSTMENT OF THE TUNING COIL

So many questions are received regarding the construction of the tuning coil and how to connect it to the circuit that it is deemed advisable to repeat the description contained in Mr. Laughter's article on "Wireless Telegraphy Made Simple," which explains a simple form of coil easily made by any amateur.

Such a coil consists of an insulating cylindrical frame wound with 115 turns of No. 18 bare tinned copper wire, the turns being 3-32 of an inch apart. Slide wire contacts are provided which work up the frame and make contact with the various turns of the wire. The scale is provided in order that the operator may note the number of turns to use, with a station of a certain wave length. The connections of the receiving tuning coil are shown in the diagram.

Considering that all the instruments have been connected at both sending and receiving end, we may begin the tuning. The operator at the sending end sends out a certain letter at certain intervals, of, say, one minute each, he continues to send and regulate the movable contact over his tuning coil, noting at what points the adjustments are made. At the receiving end the operator moves the slide wire contacts of his receiving coil synchronously with the sending end. When the point is reached where the clearest indications are heard, note is made of the time and compared with the operator at the sending end. It will be well, however, to go over this operation several times so that the best point will be found.



CONNECTIONS OF TUNING COIL

WIRELESS QUERIES

ANSWERED BY V. H. LAUGHTER

Condenser Operation

Questions.—(A) Kindly explain how a condenser bridged around the interrupter on a spark coil prevents sparking at contact points? (B) How is a circuit made through a condenser when the positive and negative coatings are separated by a glass plate? (C) Does the installing of a new telephone in a subscriber's house necessitate the erection of a new wire from the exchange to the subscriber?—H. G. N., New York, N. Y.

Answers.—(A) Refer to the article "Spark Coil Construction and Operation" in the May issue.

(B) See answer to A. R. W. in this issue.

(C) Several telephones can be worked on one line by the addition of some special

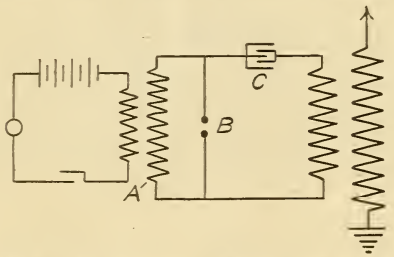
selective signalling arrangement. We would refer you to the telephone manufacturers for more extended information.

Spark Coil; Condenser Operation

Questions.—(A) What is the approximate spark length of the following coil: Core 6½ inches long, ½ inch in diameter; distance between coil heads, 5 inches; diameter of coil, 3½ inches; primary two layers of number 18 B. & S. cotton covered wire; secondary 12 ounces of number 32 B. & S. cotton covered wire; condenser 70 sheets of tinfoil, 3 by 6 inches; vibrator, usual type. (B) Please show by diagram how to bridge a spark gap with Leyden jars? (C) Can Leyden jars be used for a condenser in above coil? If so, are they connected in the same way as ordinary type of condenser? (D) Please explain the passage of an electric current through a condenser.—A. R. W., Buffalo, N. Y.

Answers.—(A) The coil would give ⅜ to ½ inch spark.

(B) The usual method is shown in the diagram. (A) represents the secondary of



SPARK GAP BRIDGED WITH CONDENSER

the spark coil, (B) the spark gap and (C) the condenser.

(C) In answer to both your questions, yes.

(D) If two electrical conductors are insulated from each other and one is charged with electricity a charge of opposite sign or polarity is induced in the other conductor by a phenomenon which is known as induction. This principle is applied in the ordinary Leyden jar or condenser. The conductors in this case are separated by glass or other dielectric. If a condenser be included in an alternating circuit the conductor on one side of the plate becomes alternately positive and negative and by induction charges are produced on the conductor on the opposite side, also alternately positive and negative; therefore, if the circuit is closed, alternating current will flow through it, although there is actually an insulator in the circuit in the form of the glass plate. An alternating current wave comes along the conductor till it comes to the glass, induces a charge in the conductor on the other side which passes the wave along through the circuit. As an analogy, suppose we have a vertical, elastic wall (representing the glass plate). Now hang two pendulums so that the weights just touch the wall. Then draw back one pendulum weight and let it fall against the wall. Its force will be transmitted through the wall to the other pendulum which will be swung outward by the push exerted by the wall surface, although there has been no direct contact between the two pendulums. The motion of the pendulum corresponds to the rise and fall of an alternating current wave, the wave on one side of the wall inducing a like wave on the other. Direct current on the other hand will not pass through a condenser because there is no phenomenon of induction present because there is no rise and fall in voltage. It is the same as if we let the two pendulums rest against the wall and then pushed steadily on one of them. There is no force exerted on the other and the two are perfectly "insulated," in a mechanical sense, from one another.

Spark Coil

Questions.—(A) What size condenser would I need to cut the sparking down at the vibrator? The coil has a 6½-inch core. (B) Would linen or silk wrapped around the primary, to a thickness of 3-16 inch, be enough to insulate primary from secondary if boiled in paraffine? (C) How far would this coil send with delicate receiving instruments at the other end? (D) How many meters capacity was the tuning coil described in March issue? (E) Will you please give me instructions to make a condenser for receiving end?—R. P. G., Salisbury, N. C.

Answers.—(A) The coil you describe will give a fat spark and send to a good distance for wireless use, but we doubt very much if the spark will be one inch long. Approximately 1,000 square inches of foil should be used for the condenser.

(B) Yes.

(C) Possibly five or six miles.

(D) We do not know exact number of turns and therefore cannot give you a suitable answer.

(E) Condensers for the receiving end are of numerous types. To describe a variable condenser would take up too much space for this department. A fixed type which is often used can be made by building up with alternate tin foil sheets three by four inches in size, on paraffine paper. Six such sheets would answer. By referring

to the article on "Spark Coil Construction and Operation," Part I, you will find a more complete description of how to build up a condenser.

Transformer

Questions.—(A) I have a closed type of transformer operating on the 110 volt A. C. current. I use no interrupter or condenser and obtain a quarter inch spark. About how far can I send with such a spark? Would an interrupter and condenser improve spark and if so, what type of interrupter shall I use? Should the key be placed in the primary or secondary circuit? (B) By using a chemical rectifier, as was described in the March number, could I successfully operate the closed core transformer, using either a make and break interrupter or electrolytic interrupter? (C) By using lamp resistance, would the current from the rectifier operate a wireless spark coil?—G. A. L., Springfield, Ill.

Answers.—(A) You should be able to send up to 50 miles under good working conditions with this transformer. The interrupter or condenser would prove of no advantage. However, in the secondary circuit a battery of condensers should be included. The key should be placed in the primary circuit.

(B and C) Transformers are not used with interrupters. The transformer will give good results if operated direct on the 110 a. c. circuit. By using a lamp resistance, as you state, the current would operate a spark coil.

Coil Operation with Interrupter

Questions.—(A) Will it injure an induction coil of the following dimensions to use it on 110 volt alternating current with a Wehnelt interrupter: core 1 inch in diameter, 8 inches long, wound with three layers of No. 12 D. C. C. wire; insulating tube between primary and secondary $\frac{1}{8}$ inch; secondary wound with $4\frac{1}{2}$ pounds No. 34 D. C. C. copper wire in 40 sections with paper insulation between each; section 4 inches in diameter boiled in paraffine wax? (B) What size spark ought I get with this coil? How long may I leave the current on without injury? (C) How much resistance ought to be interposed and should the lights be connected in parallel? (D) Are Leyden jars bridged across the spark gap necessary? (E) Is it necessary to use a condenser on the receiving set and of what use is it?—R. S. K., Owensboro, Ky.

Answers.—(A) The coil can be used on the a. c. circuit, but it would be advisable to connect an ordinary lamp in series.

(B) The spark would be very short. If you get a $\frac{1}{8}$-inch spark you can consider the results to be excellent. By using the lamp resistance the coil can be used indefinitely without injury.

(C) You can determine the exact amount of resistance best by actual experiments.

(D) The set would not operate at all unless the Leyden jars were used.

(E) Not unless the receiving set is of the tuned circuit type. The condenser serves to cut down the static currents and is a necessary part of the tuned receiving set.

Wave Length; Detector; Antenna

Questions.—(A) About what wave length do most of the large wireless stations use? (B) Will it damage copper wire to burn the insulation off? I want to use it in my antenna. (C) Can the platinum wire out of an electric light globe be used in making an electrolytic detector?—L. L. K.

Answers.—(A) Four hundred and twenty-five meters is the wave length in use by the majority of the commercial stations.

(B) Not unless the insulation is too heavy.

(C) A very simple detector can be made by breaking the top of an incandescent lamp and removing the filament, leaving the platinum wires exposed. A solution of nitric acid is now poured into the bulb, and the connection made the same as for usual type of self-restoring detector. Such a detector, however, is not very sensitive.

Spark Coil; Receiving Set

Questions.—(A) Would a six-inch spark coil send messages fifty miles? (B) Would the amateur receiving apparatus described in the February number receive up to the above named distance? (C) What amount of battery and what kind would be needed to operate a six-inch spark coil?—L. T., Minneapolis, Kan.

Answers.—(A) For sending up to 50 miles we would by all means recommend a 400-watt transformer.

(B) Yes, if connected to an aerial of about 100 feet in height.

(C) Six to eight common dry cells would operate the six-inch coil.

Spark and Tuning Coil

Questions.—(A) Can the jump spark coil that is used for gas-engine ignition be used for a $\frac{1}{8}$-mile wireless set? (B) If not, what size induction coil should be used? (C) Please explain the use of the tuning coil. (D) Is it necessary to use a tuning coil?—J. H. K., Cleveland, Ohio.

Answers.—(A) No.

(B) One-fourth or one-half inch.

(C) To regulate the wave length.

(D) No, not for ordinary experimental purposes.

ELECTRICAL MEN OF THE TIMES

FRANK W. FRUEAUFF

A new president has just been chosen for the National Electric Light Association, the great national organization of representative electric central station men. His name is Frank W. Frueauff, and he hails from Denver—City of Lights. He said on one occasion, "You can tell the whole electrical fraternity that we believe in sensationalism, out in Denver, in the matter of electric central station advertising," and that is the keynote of his success—to tell all the people, all the time, by every conceivable method, of the advantages derived from the use of electricity.

Although only 35 years of age, Mr. Frueauff has been identified with the lighting companies of Denver for nearly 18 years. It is a long climb from meter-reader to vice-president and general manager, but he made it in 13 years and has held the latter position with the Denver Gas and Electric Company since 1904.

But the guiding of the destinies of this large plant—in itself enough for almost any man—is not his only work. He is also a partner of Henry L. Doherty & Co., owners and operators of a score of large lighting plants scattered throughout various states from Colorado to the Atlantic, and familiarly known as the "Doherty interests." Consequently he holds executive positions in a large number of these individual companies which are controlled from the central head—the Doherty company. He is vice-president of the companies at Lincoln, Neb., Pueblo, Colo., Lebanon, Pa., and of the Doherty operating company. In addition he is secretary of the Lacombe Electric Co. in Denver, treasurer of the Summit County Power Co. in Colorado and director of the Massillon (Ohio) Electric and Gas Company.

Mr. Frueauff holds memberships in the National Electric Light Association, the National Commercial Gas Association, of which he is past president and in the Colorado Light, Power and Railway Association. He is well known in these associations, and this, together with his approachable, likeable and interesting qualities, has won him a host of friends from 'Frisco to New York City.

Out of the dreams that busied the young mind in the days when Leadville spelled the boundaries of Frueauff's life has come a career which has made the electrical world pause and take heed. The tribute which one of the largest newspapers in the city of his activities pays to him shows the general esteem in which he is held.

"It is just another little story of the self-made man, another illustration of the limitless possibilities for the boy of courage and nerve and persistence who stands strong against the winds of adversity.

"All great men did not begin their careers on the street corner in the company of the veriest gamins, but many great men did. And if they did not, they like to talk as if they had.

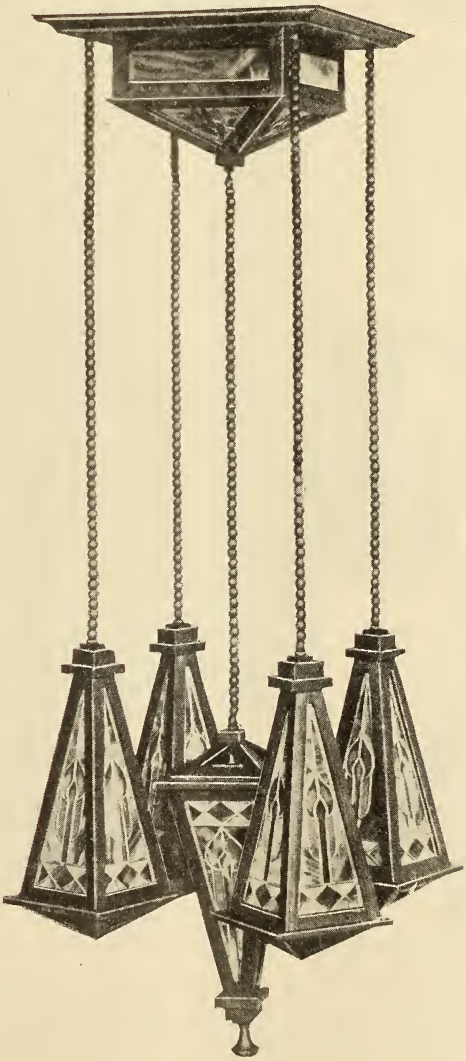
"When the National Electric Light Association, in session at Atlantic City, N. J., tendered its highest office to Frank W. Frueauff, a note of encouragement to struggling young manhood was flashed across the country and reverberated through the mountain fastnesses of Colorado, where Frank Frueauff used to dream of success and make his plans for a future which reckoned on no compromise with the little word 'Fail'."

ELECTRICITY IN THE HOUSEHOLD

MISSION DESIGNS IN LIGHTING FIXTURES

From the old Spanish regime in California, with its memory of Franciscan friars, we have adopted what is known as the Mission style of furniture and interior decorative finishings. Symmetrical and plain, this style lends a quiet elegance to a room which must not be marred by the harsh glare of metallic fixtures. A room so finished should therefore have Mission lighting fixtures, of which there are various types now available. They are made almost entirely of wood and stained art glass, the same stern lines and massive structure prevailing as in the furniture.

A few noticeably artistic designs of electric fixtures here shown will meet the approval of those who contemplate following the Mission style. The fixtures are made up complete, ready for use, even to the sockets for the incandescent bulbs. The material is carefully selected oak, weathered finish, hand rubbed and waxed. It is hard to imagine a more artistic hanging fixture than the six-light piece for lofty rooms or for a high ceiling reception hall. The four pendants are about four inches square by thirteen inches high, wired for one light each. The upper ceiling piece, from which the four pendants are hung, is also illuminated by two lamps, either plain glass or art glass being used. Manifestly a simpler adaptation of this style would be to use a single one of the pendant lights for den or vestibule.

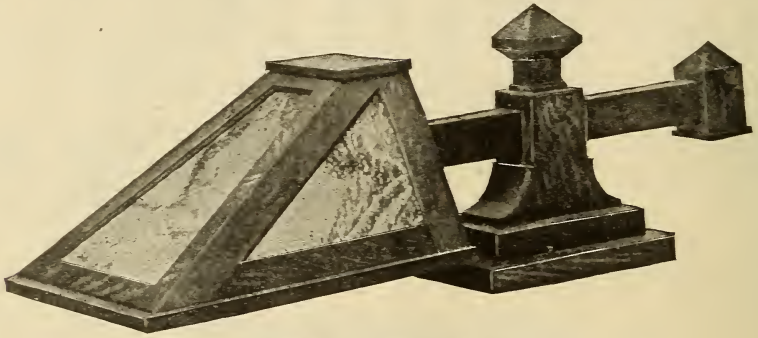


SIX LIGHT CEILING FIXTURE

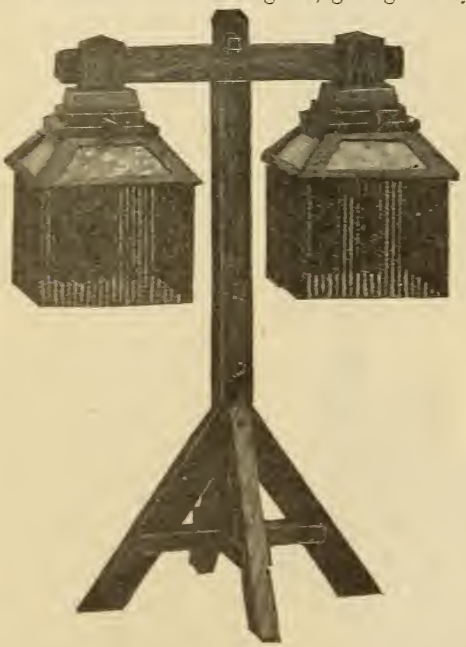
Appearance of the piano or desk may be greatly improved by a lamp fixture made especially for the purpose, and at the same time a soft light may be thrown directly on the desk or on the music and piano keys. The combined desk and piano lamp shown in one of the illustrations is adjustable, the arm holding the lamp and shade being slidably mounted in a base piece sufficiently

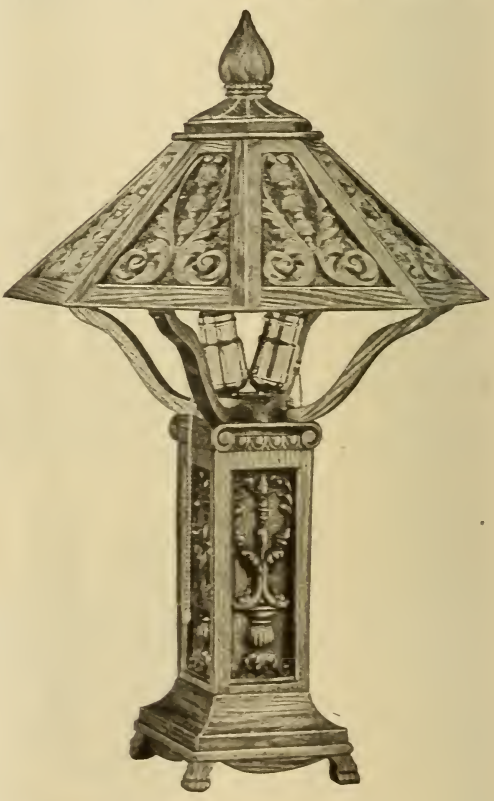
heavy to maintain the equilibrium of the unit. Two styles of electric portables are also shown, being designed for two lights each. The one at the left stands 24 inches high with a spread of 18 inches. It is strictly Mission in design and will harmonize and lend effect to any room finished in Mission exclusively. The shades are of plain or art glass with seed or cut bead fringe. The other portable is of about the same height with hand carved wood panels in the shade, back of which is the art glass, giving a very pretty effect. The base is also hand carved, with carved inserted panels. This latter makes an especially elegant portable for the parlor. Both are furnished, of course, with the necessary cords and plugs for attachment to the lamp socket.

The above are only a few examples of the many beautiful designs which may be worked out in the quaint style which had its beginning so many years ago when the old friars were their own architects and builders and their materials hewn timbers from the forest trees surrounding the mission houses in the wilderness.



PIANO OR DESK LAMP

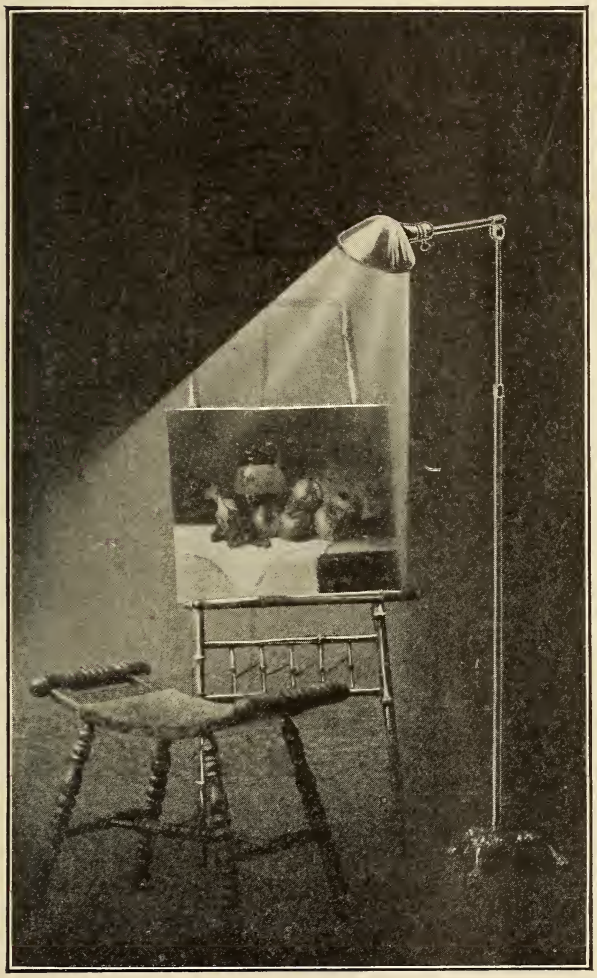




TWO LIGHT ELECTRIC PORTABLES

PORTABLE FLOOR LAMP

A portable floor lamp is a welcome addition to the electrical equipment in any home, and is just the thing for a card game in the evening, when a table light is in the way, or for the piano, or to read by when you wish to be at ease in the Morris chair



PORTABLE FLOOR LAMP

in any part of the room. Such a lamp is shown in the picture illuminating an easel and painting. The lamp is made with a black enamel iron base or stand on which is a six-foot upright of old brass finish. At the top is a one or two-foot arm for carrying the lamp and shade, which can be swung in any direction. The lamp can be adjusted to any height without the annoyance of thumb screws.

PERFECTING THE ELECTRIC IRON

No source of heat is so well adapted for ironing work as electricity, which is always ready in an instant and ceases to be, the very moment it is dismissed. Ironing by electricity banishes the hot, dirty and bothersome stove and the oppressive, heated atmosphere of the laundry. It saves countless steps and precious energy. It saves about half the time and permits the ironing or pressing to be done at any time or in any place from the ladies' boudoir to the back porch. The cost of operating is very slight, in fact, less than any other method.

The electric flatiron, the inventors found, could not be perfected as it ought to be until a different and better heating unit was discovered. The heat in an electric flatiron is the result of the electric energy "working" to get over a certain resistance. This resistance in the old irons was in the form of coils of German silver wire which heated nearly red hot when the electricity flowed through. It was to improve this "heating source" that a small army of scientists and inventors went to work in their laboratories testing all the common and rare metals and experimenting with the different alloys.

The result of all this laboratory research was the discovery of "calorite," a new high resistance alloy for a heating element that has 70 times the resistance of copper and three times that of German silver. This new metal is capable of withstanding oxidation to a point several hundred degrees hotter than any metal previously used for electric heating purposes as it melts only at the extreme temperature of 2,370 degrees Fahrenheit.

Nearly all of the experimental electric irons depended upon coils of German silver wire or kindred alloys for the necessary heat. But with the discovery of "calorite" it is now possible to stamp out a single flat grid or leaf shaped unit conforming to the face of the iron; this can be clamped firmly in the body of the iron insuring an even dis-

tribution of heat over the working surface and supplying the energy where it is most needed, along the toe, heel and side of the iron. The new leaf unit is as durable as the iron itself.

With an indestructible heating unit and good substantial plug and cord connections there is nothing to wear out about an electric iron and nothing to get out of order. There is no reason why such an iron should not wear a lifetime.

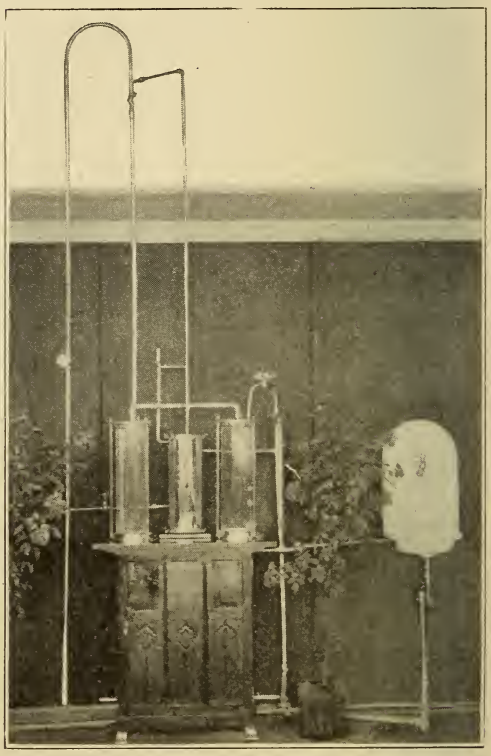
OZONIZING WATER

Ozone is a form of oxygen which chemists represent by the formula O_3. It is made up of molecules containing three atoms of oxygen instead of two as in the ordinary form of oxygen as it exists in our atmosphere. But the ozone molecule is very "unstable" and will not exist as such for any great length of time. The bond which holds its atoms together is very weak, and one of the atoms is bound very soon to tear itself away and combine with an atom of some other element for which it has a stronger affinity—for instance, carbon. Now the solid matter of ordinary germ life consists largely of carbon, so the ozone readily parts with some of its oxygen atoms to combine with the carbon of the germs, thereby "oxidizing" the carbon, which amounts really to burning. Thus germ life is destroyed by ozone.

This principle is applied in various ways for purposes of sanitation, particularly to the purification of water. The city of Paris, after many years' experience with sand filtration, has recently adopted a process of purifying its water supply, derived from Marne River, by means of electrically produced ozone. This decision has been reached after ten years of careful experiments in which ozonization has been placed in competition with filtration in all its forms.

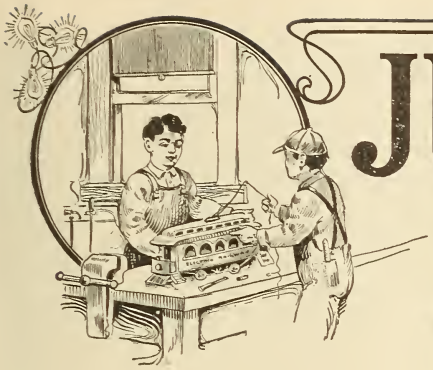
But the ozone process is not alone applicable to work on a large scale, for apparatus is now made for purifying small quantities of water to be used in the home. A small installation of this kind is shown in the picture.

An electric switch is turned and two or three valves are opened and the operation needs no further attention. Alternating current, which is most commonly used for lighting purposes, is stepped up in voltage, by a transformer in the cabinet, to an electrical pressure of 10,000 volts. This high pressure causes the electricity to jump across an open space between hundreds of little discharge points, causing what is known to electricians as a silent discharge. This silent discharge changes the oxygen of the air into ozone. The suction of the water flowing through the system of tubes and jars above draws the ozone from the point where it is generated and at the same time causes a continuous supply of atmospheric air to pass over the discharge points. The ozone is then drawn into the pipes and mingles with the water, sterilizing it.



WATER OZONIZER

Our sweeping and dusting are already electrified: exit the broom and enter the electric pneumatic cleaner. It almost seems as though we would soon have an "electric cook and housemaid," completely automatic, capable of doing the work for a large family in a couple of hours' use per day, and started and stopped at the turn of a switch.



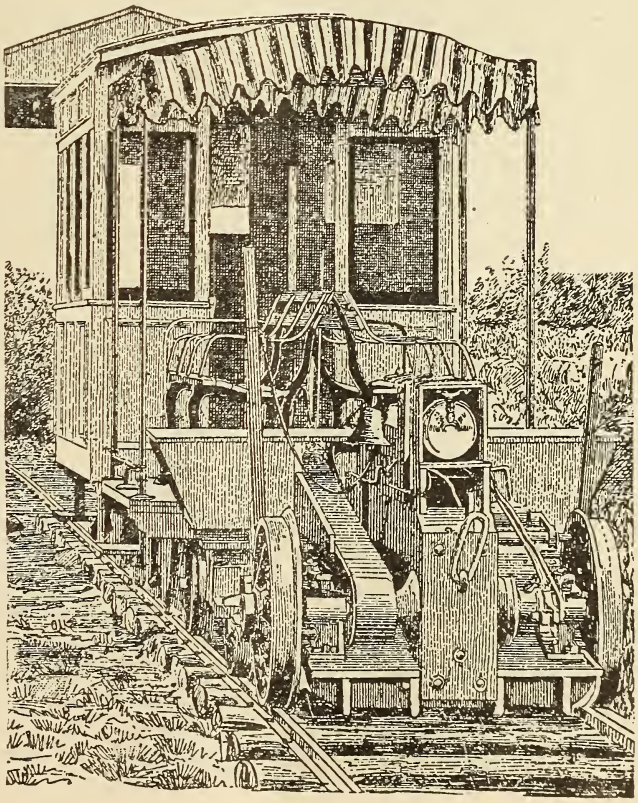
JUNIOR SECTION

EDISON'S EARLY ELECTRIC LOCOMOTIVE

Every boy who is ambitious to make a name for himself in the electrical profession of course has Thomas A. Edison as his model—Edison who invented the incandescent lamp, the phonograph and a hundred other things, and who started out in life as a telegraph operator up in Michigan. During his career Edison has had a hand in almost everything electrical and among other things he was one of the pioneer inventors in the electric railway field. In the early part of 1880 he constructed an electric railway some 90 rods in length at Menlo Park, N. Y., over which he operated one of the queerest looking locomotives that could be imagined. Some of the junior readers have doubtless never heard of this achievement of their hero, so the accompanying picture is reproduced to show this odd forerunner of the electric car.

Right in front is the electric motor, belted to the axle, and it isn't the kind of motor that is used nowadays. It is the old Edison motor—for Edison had been working on motors some time before he applied one to a locomotive. The motorman did not pound a foot gong as he does now. He rang a bell, as does the engineer on a steam locomotive. There was also an odd looking searchlight, and in the picture it appears to be a suspended incandescent lamp.

Odd as this locomotive may look today, it was nevertheless thought to be a very wonderful and perfect affair some 29 years ago.



EDISON'S EARLY ELECTRIC LOCOMOTIVE

PLAYING BASE BALL AT NIGHT

BY J. R. SCHMIDT

The first real base ball game ever played after dark took place on the night of June 17th at the National League base ball park in Cincinnati. Dating from that time, throughout the summer and fall months, there will be base ball games at night (the regulation game with regulation ball and bat), track meets and other outdoor sports. All this is made possible by one of the most wonderful electric searchlight equipments ever installed. The night baseball scheme is backed by a regularly financed company of which Mr. August Herman, well known base ball magnate, is president and manager. And it is said that over $5,000 was spent on the lighting equipment alone, in order that the Cincinnati "fans" might enjoy their favorite game after working hours.

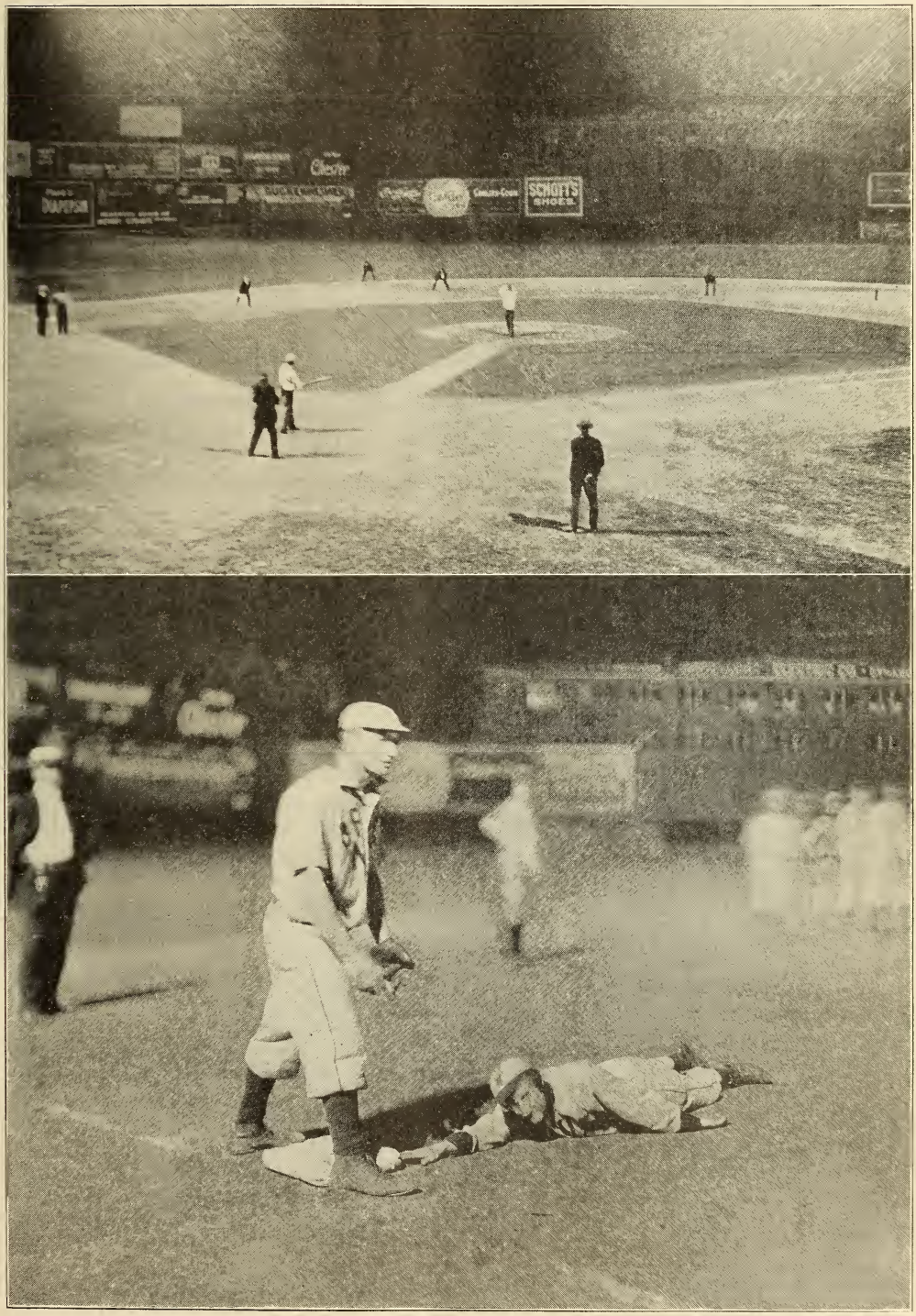
Mr. George F. Cahill, an electrical engineer, inventor of the system of illumination, says no instrument has been found as yet that will measure the intensity of the light thrown upon the field by the searchlights, but he claims that the illumination from a single lamp is many times stronger than that from any other known electric light. It is evident that the light must be strong and steady to permit of playing the game with any degree of accuracy. The two pictures on the next page are from photographs taken at night with no other source of illumination than the searchlight, and although there are naturally defects in the negatives they give a good idea of the almost daylight brightness which prevails upon the field.

The construction of the lamps is original and simple enough. There is a large galvanized iron hood, bell shaped, in which burn specially constructed carbons 1⅜ inches in diameter. These lamps take current at 110 volts. No lenses are used to concentrate the rays but the hood directs them upon that part of the base ball field where they are most needed. The current supplying these lamps is manufactured upon the grounds by an alternating current dynamo of 235 volts, 250 horsepower. There are 14 lamps in all and the excess current developed is taken care of by large wire rheostats as shown in the detail picture of the lamp.

These unique lamps are located at convenient points encircling the big field.. Ten of them are mounted on steel towers 100 feet in height. They are arranged in pairs and their illumination is so intense that every corner of the field is almost as bright as daylight.

The towers are so situated that there are lamps behind each fielder while others are mounted upon the roof of the covered bleachers and the grand stand, but situated so that their rays will not blind the players.

SEARCHLIGHT AND TOWER



PLAYING BASE-BALL AT NIGHT ON THE ELECTRICALLY ILLUMINATED FIELD IN CINCINNATI

SELF EXCITED ALTERNATOR

BY FRED R. FURNAS

There are a great many interesting experiments possible with alternating current, which the average student of electricity cannot perform on account of not having this form of current available.

The device illustrated in this article shows how any small shunt wound, two-pole direct current dynamo may be converted into what is known as a "self-excited" alternator. If your dynamo is series wound, that is, with the two field coils connected in series with the armature, you cannot use this device unless you "excite" or energize the field from dry batteries in a separate circuit. The field coils of all dynamos, whether alternating or direct, must be supplied with direct current, as alternating current reverses its direction of flow many times per-second, and the magnetism set up through the armature would reverse just as often, preventing the dynamo from generating current.

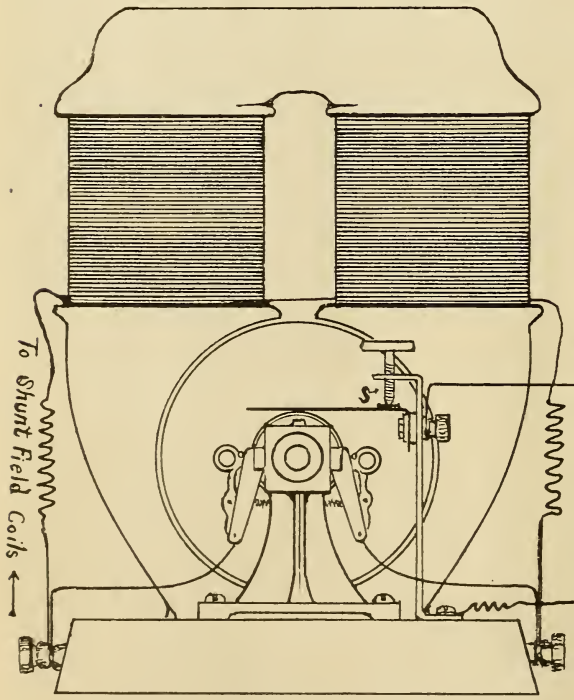


FIG. 1 SELF EXCITED ALTERNATOR

In large alternators the necessary direct current for the field is generally obtained from a small direct current generator, under which arrangement the machine is said to be "separately excited." In some machines, however, a commutator is used to change part of the armature's output to direct current for exciting the fields. The machine is then "self-exciting," and to this class Fig. 1 belongs. Fig. 2 shows the armature

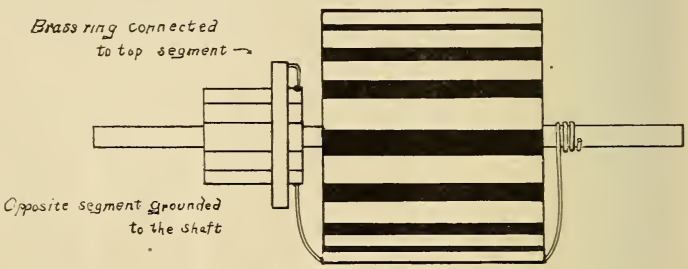


FIG. 2. METHOD OF CONNECTING

core with the windings left off to avoid confusion.

Connect a segment of the commutator to the shaft in any convenient way, soldering the joints. The writer used the method shown in the drawing, connecting to the shaft on the back side of the armature by means of a wire, as the windings interfere with getting to the shaft on the front side. There is usually room enough under the armature bands to push a wire through one of the slots as shown.

Alternating Current

The segment directly opposite the first is connected to a brass or copper ring mounted on the fibre clamping ring used on all small commutators to hold the segments together. In attaching your brass ring, be sure that it is insulated from the commutator.

The brush holder is rigged as shown in Fig. 1, with a rather stiff strip of spring brass for a brush to rub on the ring. The binding post bolted through the upright iron support must be well insulated from the latter, and a small flake of mica must be pasted under the point of the adjusting screw (s).

The binding post attached to the brush

is one terminal for the alternating current. The other terminal for the alternating current may be connected to any convenient place on the iron frame of the dynamo, where it is handy to attach a wire. Wipe the oil from the bearings, and use graphite instead, although this is not strictly necessary. Only just enough direct current will be taken from the armature to magnetize the field, when alternating current is being delivered, but if so desired, alternating current and direct current may both be taken out at the same time, the direct current being taken off from the commutator brushes in the usual way.

ELECTRIC ALARM CLOCK

The accompanying diagram indicates an easy way to rig up an electric alarm and is practically self explanatory, (A) and (B) being the points of contact and the dotted lines being the connections made at the back of the board on which the apparatus is mounted.

The board is about 10 by 12 inches and has an ordinary bracket shelf about four inches wide. The battery (one dry cell) stands on this shelf, also the clock, which is an ordinary alarm clock of cheap grade. Under the shelf or in any part of the room or in another room is fixed a $2\frac{1}{2}$ inch call bell with an ordinary one-point switch.

Contact points (A) and (B) are merely two screws standing out about $\frac{3}{8}$ inch from the board and $\frac{3}{8}$ inch apart, to which the wires are attached, and (C) is a small screw hook on which to suspend the clock.

Simply wind the clock and set the alarm at whatever time you wish, placing the key on the back of the clock which winds the alarm perpendicularly between (A) and (B). The switch is then put on the connecting point. When the alarm goes off the key at the back of the clock turns, connecting points (A) and (B)., which completes the circuit and rings the bell, until the switch is turned off.

SIMPLE ELECTRIC HEATER

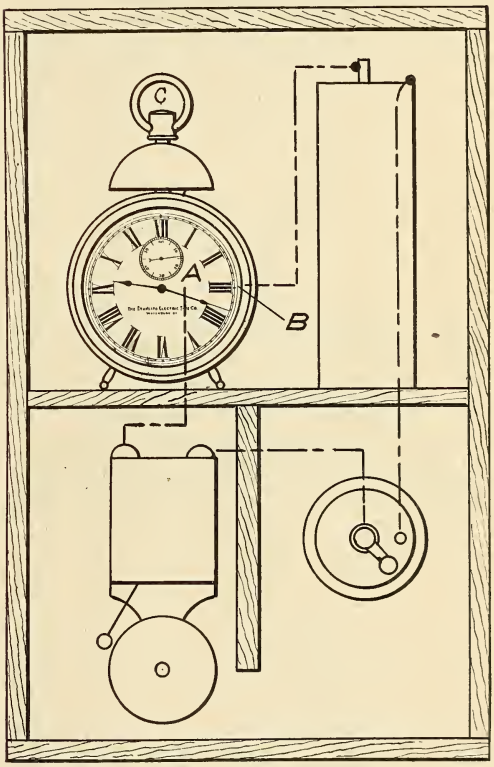
BY PHILIP M. EAMES.

It is a simple matter to build a small electric heater, which, although it may not be quite as efficient as the ones turned out by the big companies who have spent years in experimenting on the subject, nevertheless will be found to work quite satisfactorily and will at the same time afford the builder a new type of apparatus on which to demonstrate his constructive ability.

The material needed (and cost of same) to build an electric heater are as follows:

3 feet No. 14 asbestos covered wire	.10
2 pieces of sheet copper 14″ x 6″ x 1-32″	.35
2 pieces of sheet asbestos 14″ x $3\frac{3}{4}$″ x $\frac{1}{4}$″	.10
1 piece of sheet asbestos 12″ x 2″ x $\frac{1}{4}$″	.05
50 feet No. 14 bare german silver wire	.20
Total	.80

Proceed to wind 108 turns of the German silver wire around the small piece of asbestos,



ELECTRIC ALARM CLOCK

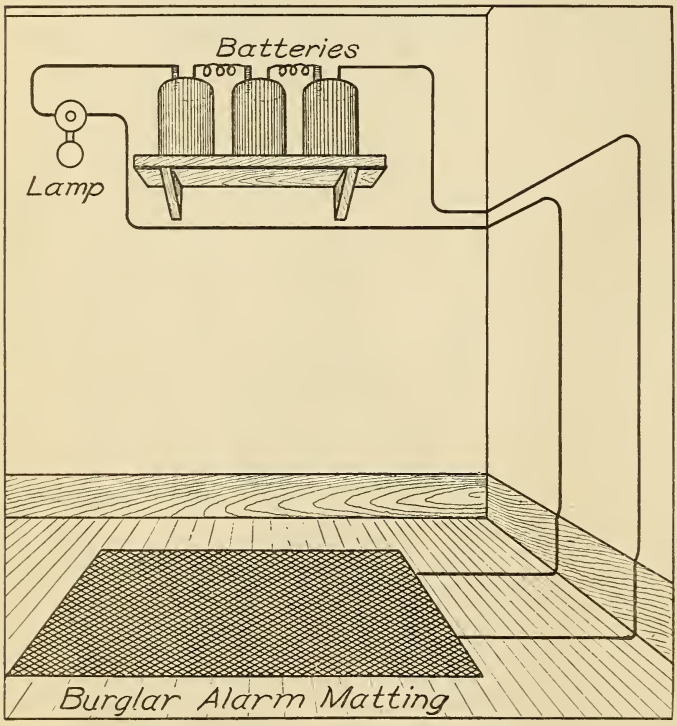
seeing that they do not touch at any place. Put the two loose ends of the wire through the asbestos to hold them firmly.

Place this piece of asbestos (the one with the wire on it) between the two larger pieces and bolt them together with some binding posts (the ones that come off the carbon in dry batteries will do). Connect the asbestor covered wires with the ends of the resistance wire, and run them out of one side of the heater. Put the whole between the copper sheets and rivet them together.

This heater will be suitable for 110 volt alternating or direct current.

AUTOMATIC BEDROOM LIGHT

A very convenient bedroom light may be fitted up by using what is called "burgla alarm matting," obtained at electrical supplyr



AUTOMATIC BED ROOM LIGHT

stores. This matting is made especially for the purpose and is so interwoven with wires that merely stepping on the mat at any point will close a circuit connected to two terminals supplied at the edge of the mat. To arrange a bedroom light connect up as shown in the diagram.

Use a miniature six-volt lamp and three or four dry cells in series as shown. Connect one side of the battery to one terminal of the mat. From the other terminal of the mat run a wire to the lamp, and then connect the other terminal of the lamp with the other side of the battery.

Everything is now complete. In the night step out on the mat, trusty revolver in hand, and, Presto! the lamp lights up, enabling you to shoot the burglar exactly in the center of the heart. Or, if there is no burglar there, you can easily convince yourself that you only got up to see what time it was anyway.

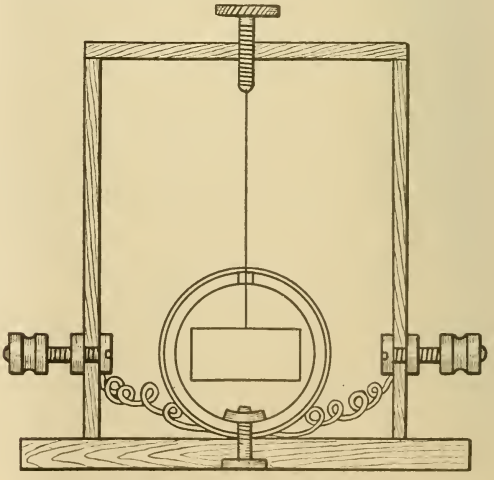
Manifestly another use for the matting would be to place it in front of the door and connected to an alarm bell instead of a lamp. In that case any one entering the door and stepping on the mat would cause the bell to ring.

PRACTICAL GALVANOMETER

BY GORDON PHILIP.

As an amateur experimenter, I have often felt the need of a delicate galvanometer, and here is the description of one I made after some experimenting. The cost is but trifling, and when well made the instrument is as delicate as could be wished.

The material used in its construction can be found around any workshop or in the scrap heap. For the core a piece of iron or steel tubing about two inches in length and the same in diameter, is needed. Drill two holes through the tube in the middle and on opposite sides as shown in the diagram. Now wind on several layers of fine wire, the more the better. Take care in winding not to let any of the turns pass over the holes. Mount the coil



PRACTICAL GALVANOMETER

thus formed on a suitable base and give the whole a heavy coating of shellac. A long battery binding post can be used in fastening the coil, the screw passing through one of the holes drilled in the tube.

The needle, or in this instance it is a vane, is an ordinary safety razor blade magnetized by rubbing it with a bar magnet. Suspend it by means of a long silk fibre. Place it in the centre of the coil and pass the thread up through the hole. The upper end of this thread is attached to the top of the case in which the instrument is to be kept. A tall box with a glass front will do for the case. The ends of the coil are fastened to two binding posts taken from old batteries.

To use the instrument have the strands of wire parallel to the needle, which will point north and south if not close to a magnetic body. As the needle does not come quickly to rest some patience may be needed in using it. A brass pin set in the coil will prevent the needle from whirling around when the current is first applied.

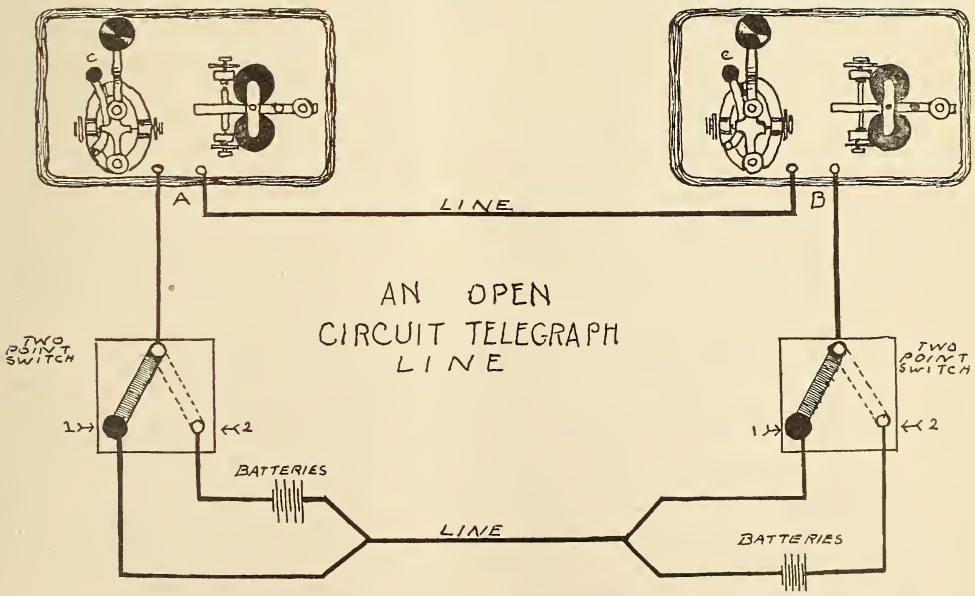
With such an instrument the current given by a small motor, when the armature is whirled in the fingers, can easily be detected by the deflection of the suspended blade, and with five or six cells the current that passes through a person's finger can be registered if a little care is taken.

AN OPEN CIRCUIT TELEGRAPH

BY GLEN M. ROYSTON

The plan for an open circuit telegraph system shown in the diagram differs materially from the one shown in the March issue of Popular Electricity, and no doubt some of the junior readers will find pleasure and experience in building and operating such an equipment. The diagram shows very plainly how all the parts are connected, and when properly put together the mode of operation is as follows:

When the line is not in use, the switch is kept on (1) in the two point switch and the circuit breaker (c) is closed. This applies to both ends of the line.



OPEN CIRCUIT TELEGRAPH

Now suppose (A) wishes to talk to (B). He puts his switch over on point (2), which brings his batteries into the circuit. Then (A) calls in the usual way. The batteries at each end must be strong enough to run both instruments on one set of batteries.

QUESTIONS AND ANSWERS

Readers of Popular Electricity are invited to make free use of this department. Knowledge on any subject is gained by asking questions, and nearly every one has some question he would like to ask concerning electricity. These questions and answers will be of interest and benefit to many besides the one directly concerned. No consideration will be given to communications that do not contain the full name and address of the writer.

Magnetic Release Locks

Question.—I wish to install some electric door locks in my home and do not know just how to arrange them. I want to operate them with dry batteries. Will you give me some idea by drawings how these locks operate, how they are installed, and the best way to connect them.—E. F. S., Chicago, Ill.

Answer.—In Figs. 1 and 2, the interior parts of a magnetic release lock are shown. Similar parts are lettered alike in all figures.

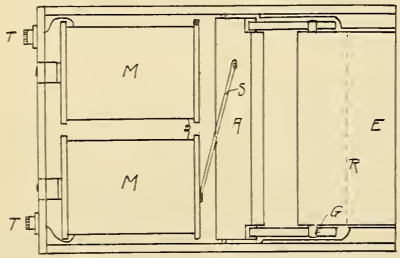


FIG. 1. MAGNETIC RELEASE LOCK—SIDE VIEW

Two dry cells connected as illustrated in Fig. 4, through a push button, (PB) are sufficient for operation. From (T) the circuit leads through the coils, (MM), in series. Closing the circuit through the button,

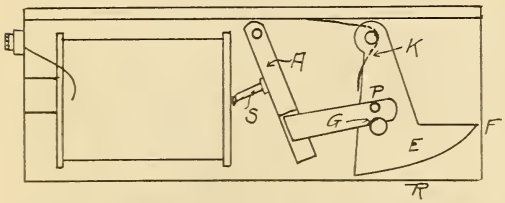


FIG. 2. MAGNETIC RELEASE LOCK—PLAN

(PB), energizes the core of the magnets, (MM), attracting the soft iron armature, (A). This pull is just strong enough to overcome the tension of the spring, (S). Referring to Fig. 2, (G) is released, and (E) may be pushed back against the force exerted by spring, (K), the release arm (A) being pivoted at (P). In Fig. 3 is shown a spring plunger, (SP). As soon as (E) is released by operating the push button (PB), the spring plunger (SP) pushes the door (E) back along (D), allowing one to pull the door open. These locks are made with the catch (E) extending, as in Fig. 3, or as in Fig. 2, flush with the edge (F) and open

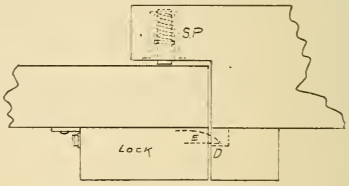


FIG. 3. SPRING PUSH

under (E) at (R). This lock can be operated only by current through the coils, no other means, as a key, being provided for.

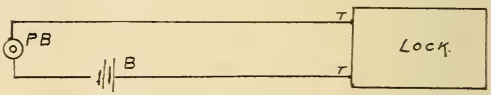


FIG. 4. CONNECTIONS

If the lock is placed on the door, Fig. 3, and the wires concealed in the woodwork, two sliding contacts should be placed at the upper hinged corner of the door.

Making an Electromagnet

Question.—Will you tell me how to determine the pull of an electromagnet?—H. McN., Corocal, Canal Zone, Panama.

Answer.—Knowing the kind of metal of which the magnet is made, look up in tables compiled for this purpose the number of lines per square inch this metal carries at the saturation point, and also the number of ampere turns necessary to cause this flux density. Having a given voltage to work with use the wire whose resistance is such that by ohm's law, $(C=\frac{E}{R})$, C is what is required. Then from formula

$$B=1316.6\sqrt{\frac{\text{Pull in pounds}}{A}}$$

where B=lines per square inch of magnet, and A=lifting area of magnet in square inches, by substituting, the pull in pounds may be determined.

Magnetos; Edison Three Wire System

Questions.—(A) What is the voltage ordinarily obtained from a telephone magneto-generator? (B) May a magneto armature be wound with heavier wire for lower voltage and equipped with a commutator for direct current? (C) Can a magneto be run continuously without weakening the field? (D) Is blue vitriol the only necessary chemical to make a gravity battery? (E) Explain the Edison three-wire system.—O. M., Wayland, Mich.

Answers.—(A) The voltage given by a magneto generator depends upon the speed of the armature, the number of turns of wire on the armature, the strength of the magnetic field and the spacing between the armature and the field faces. One thousand revolutions per minute is the usual speed of hand driven magnetos. The voltage varies from 40 to 80 volts.

(B) Yes, both field coils and armature may be wound this way to reduce the voltage and increase the current output. The voltage, it must be remembered, however, is directly proportional to the number of conductors on the armature. The armature may be equipped with a commutator to furnish direct current.

(C) Yes, if not subject to vibration or shock, for as you know this tends to lessen permanent magnetization. A permanent bar magnet may be demagnetized by several sharp taps from a hammer.

(D) Yes.

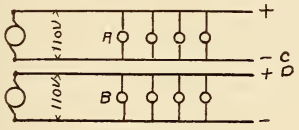


FIG. 1.

(E) Briefly, to step up to the principle of the three-wire system, let Fig. 1 represent two two-wire circuits, each operated by 110-volt dynamos. Assume lamps (A) and

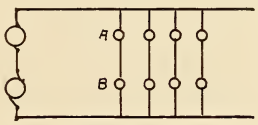


FIG. 2.

(B) placed as shown. It is plain that they may be connected in series as in Fig. 2, which does away with two wires (C) and (D): but, in case one lamp burns out or is turned off the other goes out also. For this reason a third wire (E), Fig. 3, is extended from the middle point of the two dynamos. By this arrangement any lamp may be put out without affecting the others. This middle wire is called the neutral (±), because it is negative as to one conductor

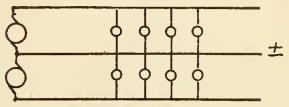


FIG. 3.

and positive as to the other outside wire. In Fig. 3 the system is balanced, that is, there are as many lamps on one side of the neutral as upon the other. If, however, as in Fig. 4, the load is not equally dis-

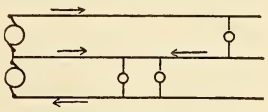


FIG. 4.

tributed, the neutral supplies the difference as indicated by the arrows. If the lamps are burning on one side only, the dynamo on the other side will do no work, while the neutral wire will act as positive or negative main according as the working dynamo is connected to the positive or negative main wire. The less the load is balanced the larger must be the neutral wire. This wire is seldom made less than one-half the size of the outside wires, and is often of the same size. One of the points favoring the system is the saving in copper wire. The outside wires need be only one-fourth the size required for the same power delivered by means of the two wire 110-volt system. With the neutral as large as the outside wire the total amount of copper is only $\frac{1}{4}+\frac{1}{8}$, or $\frac{3}{8}$ of that required for the two-wire 110-volt system.

Condenser Capacity; Bell Operated by a Solenoid

Questions.—(A) Please inform me how I can make the following condensers: one of one-half microfarad capacity and one of two microfarads. (B) Can a bell be made to operate on the principle of the solenoid, this being the hammer, and use alternating current?—W. H. F., Denver, Colo.

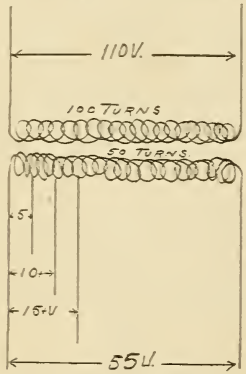
Answers.—(A) See page 35 of May, 1909, issue. A condenser of one microfarad capacity contains about 3,600 square inches of tinfoil.

(B) Such a bell could be made, the solenoid being so arranged as to open the coil circuit as it was drawn up.

Transformer Taps for Various Voltages

Question.—How may a transformer be arranged so that with its primary connected to 110-volt mains, 5, 10, 15 and 50 volts may be taken off the secondary winding?—R. H. W., North Abington, Mass.

Answer.—The diagram shows the manner of connecting taps on the secondary to secure the required voltage. Slightly more than 5,



METHOD OF CONNECTING TRANSFORMER TAPS

10, 15 and 50 volts will be obtained as 1-10 of 50 turns is included between the 5-volt taps, 2-10 of 50 turns between the 10-volt taps and so on, the ratio of the transformer being 2 to 1.

Open and Closed Core Transformers; Induction Coil on Alternating Current

Questions.—(A) What is the difference between open and closed core transformers? (B) Which is the more efficient? (C) Give dimensions of 500 watt transformer fulfilling answer to (B). (D) Can an induction coil be used on alternating current, 110 volts, 133 cycles, 5 amperes? If so, how?—F. H., Alden, Ia.

Answers.—(A) In the open core transformers the iron core forms the part on

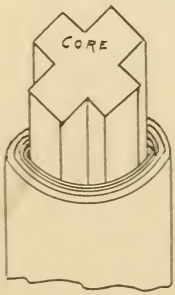


FIG. 1. OPEN CORE TYPE

which the coils are wound. Fig. 1 illustrates this type. In shell or closed core transformers the iron surrounds the coils. Fig. 2 shows the arrangement in the ordinary closed core type.

(B) One important point to observe in transformer construction is to so place the coils with reference to each other that all the

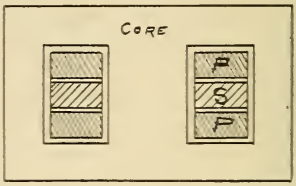


FIG. 2. CLOSED CORE TYPE

magnetic lines passing through one, must pass through the other, thus avoiding what is called magnetic leakage. We do not know that one type is more efficient than the other as leading manufacturers employ both types.

(C) Consider a core type transformer, provide a circular bundle of wire 12 inches in length by three inches in diameter, or a mass of laminated iron of the same length and cross section.

(D) Yes, by using the chemical rectifier described on page 235 of this issue, with resistance in series. See also Electrolytic Interrupter, page 245.

Six Volt Lamps

Questions.—(A) I have a 6-volt, 40 ampere-hour storage battery with which I am lighting Tungsten 6-volt lamps. They are 6 candle-power apiece. How many amperes do they require? (B) How many hours service will there be if the battery is placed on one light? (C) How many lamps can I use at one time without overtaxing the battery? (D) What are the highest candle power 6-volt lamps obtainable and where?—M. W. S., Chicago.

Answer.—(A) If you refer to the Tungsten sign lamp, would say that this lamp is rated at 8 to 12 volts, 5 watts, and 4 candle power. Watts ÷volts gives current; therefore $\frac{5}{10\text{ (average)}}=0.5$ ampere.

(B) A 40 ampere-hour battery should furnish 40 amperes for one hour or one light for 80 hours.

(C) That depends upon how long you wish to use the battery. The battery will give its rating. You can of course use up the 40-ampere-hour capacity quickly or by using little current make the battery last a longer time.

(D) The tungsten is the highest efficiency lamp now made. It may be purchased from any lamp dealer or electric supply house.

Morse Relay; Recharging Dry Batteries; Telegraph Lightning Arrester

Questions.—(A) What size and how much wire should I use to wind a 20 ohm Morse telegraph relay? (B) Would the battery solution described in answer to F. C. S., June issue, do to recharge dry batteries? (C) Please give wiring diagram and plan for telegraph lightning arrester.—C. R. R., Turner, Ore.

Answers.—(A) A Morse 20 ohm relay is wound with fourteen layers of No. 25 B. & S. gauge silk covered wire on each core.

(B) Yes.

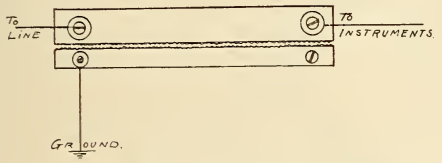


FIG. 1. SIMPLE LIGHTNING ARRESTER

(C) Fig. 1 shows connections for a lightning arrester and also the plan for same. Two strips of brass are used. The upper strip forms part of the line circuit. The lower strip is separated from the upper one by a small air space. When the line is struck by lightning the electricity jumps from the sharp points of the upper line strip, across the air gap to the grounded strip and into the earth.

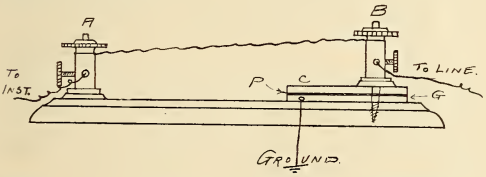


FIG. 2. COMBINED LIGHTNING ARRESTER AND FUSE

Fig. 2 shows a combination of fuse and ground plate arrester. Between binding posts (A) and (B) extends a piece of fuse wire, protecting the office apparatus in case of a cross with high voltage or lighting circuits. Two brass plates (C) and a ground plate (G) are separated by layers of paraffin paper, which, in case of a lightning discharge from the line to binding post (B), are punctured, the charge going to ground.

Induction Motor

Question.—Please inform me how I can convert a 50-volt, 125 cycle induction motor into a 60 cycle 110 volt machine; also change a 125 cycle, 110 volt machine into a 60 cycle, 110 volt motor.—F. E. B., Riverdale, Md.

Answer.—See answer to J. E. D., Dec., 1908, issue. For a good book on the subject write any publishing house of scientific books for their catalogue in this line, and select from it such as you think will answer your purpose. If you state your need they will be glad to advise you.

Condenser; Induction Motor; Volt Meter; Liquid Rheostat; German Silver Resistance

Questions.—(A) I have a one-fourth inch jump spark coil which will give a short spark and then stop for a moment. If it is the condenser, kindly tell me how to make one for the coil. (B) Will you give details of how to build an induction motor? (C) Is there any way to stop the pulsations of an alternating current? (D) Can a small voltmeter be easily constructed—one for about 90 volts direct current, that can be left on the line. (E) What liquid besides water would you advise for a liquid rheostat? (F) How much German silver wire would it take to reduce 110 volts to 10 volts?—W. J. S., Binghamton, N. Y.

Answers.—(A) Your trouble is probably in the condenser. For your coil the condenser should consist of 25, three by one and one-fourth inch sheets of tinfoil. See "Spark Coil Construction and Operation," May, 1909, issue, for details of condenser.

(B) This is a question requiring elaborate design and calculation and can hardly be answered in this department.

(C) See answer to S. N., June, 1909, issue.

(D) See "To Make a Voltmeter," April, 1909, issue. For one of higher range must refer you to standard instruments.

(E) Water and five per cent sulphuric acid.

(F) That depends on the size of the wire. 275 feet of No. 35, "30 per cent" wire will do the work.

Reducing Speed of an Induction Motor

Question.—I have an induction, 60 cycle desk fan. Is there any way to reduce the speed to a low rate and not increase the wattage?—M. S., Pine Bluff, Ark.

Answer.—The speed of an induction motor may be reduced by increasing the number of poles, which is impracticable, or by lowering the frequency. The following formula applies:

$$\frac{S=2N}{P}$$

Where S=revolutions per second,
P=number of poles,
and N=frequency in cycles per second.

See answer to J. E. D., Dec., 1908, issue.

Current Through Body; Bichromate Battery

Questions.—(A) What is the strongest current that can be taken through the body without fatal results? (B) I made a bichromate battery using a quart fruit jar and put in four ounces of sulphuric acid. Was this too much? (C) Does it do any good or harm to add more bichromate of potash than the dilute sulphuric acid will dissolve?—C. V. S., Three Oaks, Mich.

Answers.—(A) We know that some persons are killed by contact with low voltage wires, while others come in contact with high voltage and live. To explain this we must remember that the current strength depends upon the voltage and also upon the resistance of the conductor which in your question is the body. The resistance of the body has been found to be variable. Men working in a place where acid vapors or a damp atmosphere prevail might have the resistance of the body so lowered as to get a fatal current through the body by contact with a 110-volt circuit. Cases are on record where in a bath persons with the body wet, and standing on grounded metal work have been killed by 110 volts. We cannot answer your question more definitely than by referring to Herr Hermann Zipp who has given this subject much study. He tells of placing one hand on a 1,000 volt transformer between the contact terminals. His system received a severe shock but no other ill effects. He says: "If, however, the contact had been made with both hands, a current equal to 100 milliamperes (.1 ampere) would have passed through my system even if the resistance had been as high a 10,000 ohms, and death would certainly have resulted." It is also believed that the current has a chemical action upon the body's liquids, and for this reason the portion of the body brought in contact with a circuit would determine how much current could be received without injury.

(B) No.

(C) We do not know that any detrimental effect would result. The usual proportions for such a cell are: potassium bichromate, 1 part; sulphuric acid, 3 parts; water, 9 parts.

Storage Battery to Run Motor

Question.—How can I make a storage battery that will run a ⅛ H. P. motor for three hours and not be too heavy?—H. R., Muskogee, Okla.

Answer.—You do not state the voltage of the motor so we assume 80, that being common on automobiles. A battery giving 21 amperes for four hours would weigh about 42 pounds. See answer to E. F., March, 1909 issue, for construction of battery.

Hydrogen

Questions.—(A) How is hydrogen gas produced? (B) What is its lifting power per cubic foot? (Can hydrogen be compressed? (D) By compressing same could the lifting power be increased?—R. L., Visalia, Cal.

Answers.—Hydrogen may be obtained by electrolysis as explained in the May, 1909, issue. A second way is to dissolve magnesium in dilute sulphuric acid. The hydrogen so obtained is very pure. The chemical action is: $H_2SO_4+Mg=MgSO_4+H_2$. For laboratory purposes zinc may be placed in dilute hydrochloric acid or sulphuric acid. The chemical changes are:

(1) $H_2SO_4+Zn=ZnSO_4+H_2$

(2) $2\ HCl+Zn=ZnCl_2+H_2$.

(B) Allowing the specific gravity of air to be represented by 1, hydrogen has a comparative weight of .069; that is, its weight as compared with an equal volume of air is only one-fourteenth as much. In the Soudan War balloons were much used. From their tests a volume of hydrogen occupying 4,150 feet was sufficient to lift a weight of about 150 pounds 3,000 feet up into the atmosphere. Its lifting power would also vary according to the density of the air.

(C) Yes. In the war above noted hydrogen gas was put up at the gas station and sent to the front, by compressing it in cylinders twelve feet long by one foot in diameter. Each cylinder, built of strong iron weighed with the contained gas, half a ton.

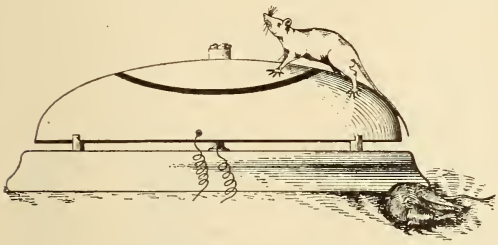
(D) You know the law concerning a body immersed in water. The body loses in weight the weight of the water displaced. Would you gain anything by compressing the immersed body into smaller space? Study your problem by assuming the water in a pail to represent the ocean of air around the earth, and a cork held at the bottom of the pail to be a balloon moored at the surface of the earth. Two men of equal weight go swimming. One is closely built and hard of muscle, the other is loosely framed and larger. Which one will have to exert the most energy to keep afloat. Why?

The legislature of North Carolina has passed a law requiring all the railroads within the state to equip their engines with electric headlights of not less than 1,200 candle-power.

NEW ELECTRICAL INVENTIONS

ELECTRIC RAT TRAP

A unique rat trap devised by Byron S. Ames of Williamsport, Pa., is shown in the sketch and is said to do the work every time. It looks something like the ordinary electric bell, only it is larger. The lower part of the metallic bell-shaped piece is connected to one side of an electric circuit.

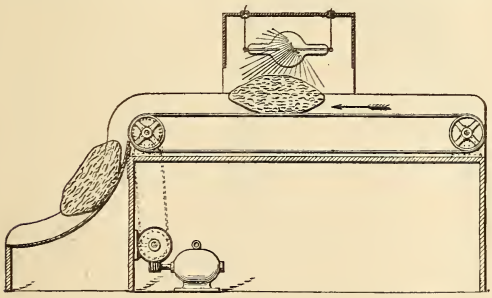


ELECTRIC RAT TRAP

The upper part, insulated from the lower part as shown by the heavy black line, is connected to the other side of the circuit. On top is placed the usual bit of cheese. When the rat goes to nibble at the cheese he steps across the two sections of the bell and receives a shock, and then it is his funeral.

A NEW WAY OF TREATING TOBACCO

It is known among dealers in tobacco and the manufacturers of products from tobacco, that in the course of a year large quantities



TREATING TOBACCO WITH X-RAY

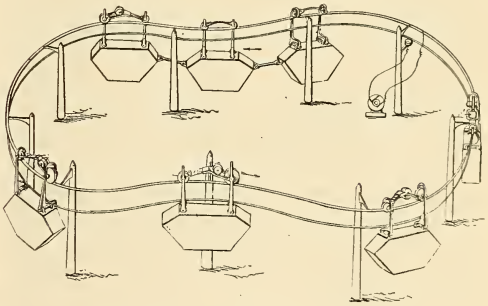
of the leaf are destroyed by small insects, the chief of which possibly is Lasiderma serricorna, commonly known as the cigarette beetle. In addition to this beetle, however, there are probably 150 other small insect creatures which prey upon tobacco and occasion its injury if not destruction. The result of the devastating action of these parasitic insects is the destruction of millions of dollars' worth of tobacco during each year.

It is the object of an invention by Franklin S. Smith of Philadelphia, Pa., to subject tobacco to a treatment which not only will destroy these insects but will also destroy their eggs, the larvæ, and the pupæ, and thus preserve the tobacco for an indefinite period. It is necessary that this treatment of the tobacco, for the purpose stated, shall itself have no deleterious or injurious effect upon tobacco.

He discovered the fact that tobacco may be subjected to the action and effect of X-rays, which occasion the destruction of the eggs, the larvæ, the pupæ and the adult insects, without injury or danger of causing deterioration of the tobacco.

ELECTRIC TELPHER SYSTEM

The term telpherage is applied to small overhead track systems on which are suspended cars or carriers which are propelled along the tracks. Numerous forms of electric telpher systems have been devised

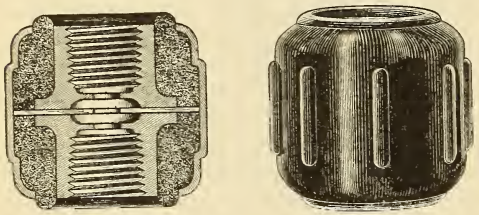


ELECTRIC TELPHER SYSTEM

which make use of electric motors for propelling the wheels of each individual car. Such a system is shown in the diagram and is the invention of Barnett W. Harris of Buffalo, N. Y. There is an upper cable which carries the weight of the cars and also forms one side of the electric circuit. Below this is a wire which forms the other side of the circuit. The special feature of the system is an arrangement whereby the cars or carriers may be operated in trains.

A NEW INSULATING JOINT

In the installation of combination gas and electric fixtures it is required that the fixture support be insulated from the main piping system at the point where it is screwed into the gas outlet. A new insulating joint of this kind is shown in the cut, showing at the



NEW INSULATING JOINT

left a longitudinal sectional view. The screw threads, top and bottom, receive the outlet pipe and the fixture support respectively, and are insulated from each other by the horizontal strip or disk. The gray material on the outside is also insulating material molded and compressed over the threaded members. Outside of all is a drawn steel casing which gives strength and protection. The stone-like insulating material is a sort of artificial quartzite and has been given the name of Di-el-ite.

ALUMINUM WELDING

Aluminum cannot be welded to aluminum by means of a blow torch, although it can be welded to other metals in this manner. Uniting aluminum to aluminum by means of solders of various kinds has also been more or less unsatisfactory, since the solder and the aluminum, being two different metals, form a sort of battery in the presence of water and the electrolytic action thus set up gradually corrodes or eats away the metals, resulting finally in a poor joint for electrical work.

The inability to make a good weld is due to the fact that at the high temperature which must necessarily be employed, a skin or film of oxide forms on the surface of the aluminum to be welded, and this film despite its extreme thinness prevents the fused edge or surface of one piece from uniting with the fused edge or surface of the other piece.

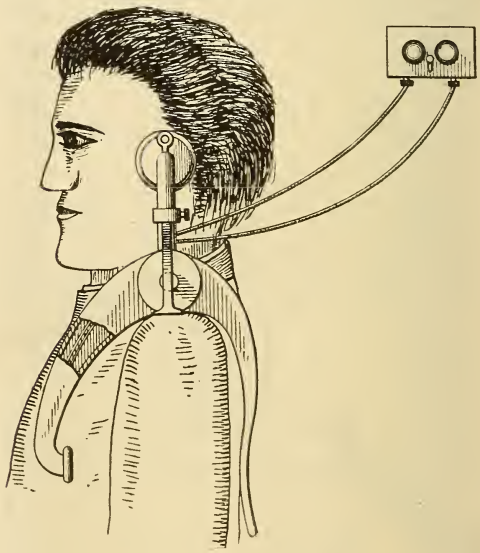
In order to make such a weld possible, a process has been patented by Max Ulrich Schoop of Bois Colombes, France, which employs a special flux which will reduce the layers of oxide which are formed, and using preferably the oxy-acetylene flame as a source of heat. This mixture consists of

Potassium chloride	60 parts
Sodium chloride	12 parts
Potassium bisulphate	4 parts
Lithium chloride	20 parts

It is preferably fused in a platinum dish, then crushed in a mortar and sufficient water added to form a thin paste. If a blow pipe flame of lower temperature than that produced by the oxy-acetylene flame be employed, such, for instance, as that produced by oxygen and illuminating gas, or oxygen and hydrogen, it is desirable to increase the proportion of potassium bisulphate in order to lower the point of fusion of the mixture.

UNIQUE TELEPHONE

Eugene Koehler of Philadelphia, Pa., is the inventor of a new type of telephone in which the vibrations of the speaker's body are made to affect the transmitter directly, rather than through the agency of air waves

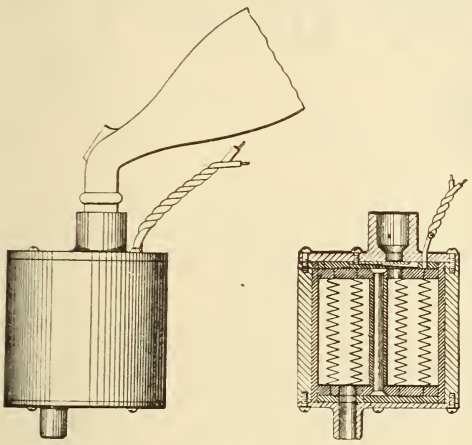


UNIQUE TELEPHONE

as in the ordinary telephone. This unusual apparatus consists of three members so arranged that when the whole device is placed upon the shoulder the receiver will be against the ear of the user, the transmitter, on a long curved arm, will rest on the breast and a clamping arm will slip down over the shoulder blade, holding the instrument in place.

ELECTRIC AIR HEATER

An electric air heater designed for use in barber shops, hair dressing parlors, etc., is the invention of Louis A. Siebert of Columbus, Ohio. It is a simple device, consisting of a small cylindrical casing of a size suitable to be held in the hand with a connection leading into it for the attachment of the tube from a source of compressed



ELECTRIC WIRE HEATER

air. Another opening for the exit of the air is supplied with a funnel shaped nozzle for dispersing the air blast. Inside the casing are a number of coils of resistance wire through which electric current is made to flow during the operation. The passage of the current through these wires causes them to heat up almost to incandescence, warming the air blast.

AUTOMATIC STREET CAR SIGNAL

An ingenious device has been invented by C. W. Mallins, general manager of Liverpool Corporation Tramways in England. The device consists in the footboard of a car working on a hinge, so that when a passenger steps on it it gives slightly and presses on an electric contact which automatically switches on a lamp near the motorman in the front of the car. The motorman then slows up in response to the signal, and as soon as the passenger alights the lamp is extinguished.

It frequently happens in double-deck cars, which are extensively used in England, that a passenger riding below wishes to alight while the conductor is on top collecting fares. Mr. Mallins' invention will obviate the necessity of searching for the bell rope.

BOOK REVIEWS

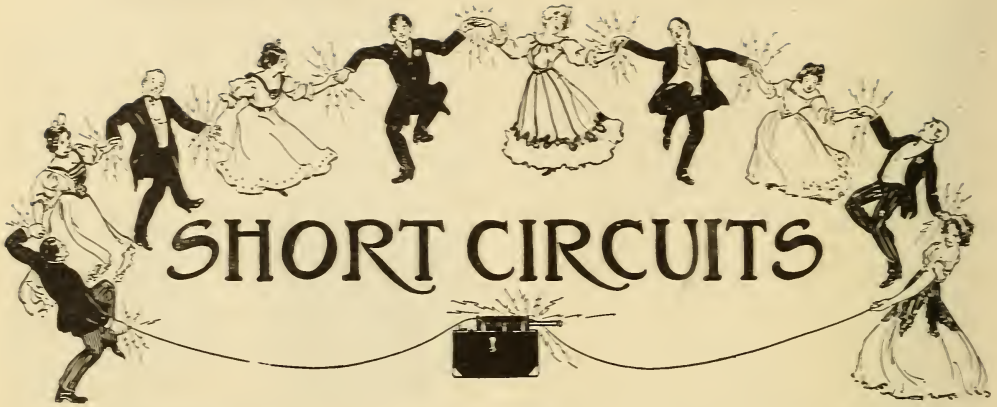
Operators, Wireless Telegraph and Telephone Handbook. By Victor H. Laughter. Chicago: Frederick J. Drake & Co. 1909. 180 pages with 87 illustrations. Price, $1.00.

A book to strike the happy medium between treatises too rudimentary on the one hand and those too technical on the other will be appreciated by a large class of experimenters in wireless telegraphy, of whom there are literally thousands in the country today. Such a book has been written by the able young wireless expert Mr. Victor H. Laughter, who is well known to the readers of Popular Electricity through his many valuable contributions to its pages. Mr. Laughter had been long impressed with the fact that a book was needed which would not only teach the amateur the principles upon which modern wireless systems depend but also one which would explain clearly how to go ahead with the construction of simple equipments, which are among the most interesting of all electrical experimental apparatus. In this he has succeeded admirably and the book stands as one of the best elementary treatises for amateur experimenters to date. In reading over the text we find, naturally, a little at the beginning upon the history of the art and something about the early methods employed. But this is cut very short and the reader is plunged almost immediately into the practical subject of how to build a simple wireless set.

Wireless telephony, now that it is a demonstrated success, is arousing much interest in the minds of those experimenters who cannot rest until they have built an equipment which will actually transmit articulate speech without the agency of wires, so a chapter of the book is devoted to this important subject, describing the De Forest system, the Bell radiophone, the speaking arc, etc.

How Telegraphs and Telephones Work. By Charles R. Gibson. Philadelphia: J. B. Lippincott Company. 1909. 156 pages, with 15 illustrations. Price, 75 cents.

A small book written in simple non-technical language, dealing with telegraphs and telephones, such as would be useful to those who are specially interested in those instruments. A chapter on wireless telephony, and a short discussion of the electron theory, bring the volume thoroughly up to date.



Student (who is taking his girl out in his auto)—Fifty miles an hour! Are you game?

The girl (as she swallows another pint of dust)—Yes: I'm full of grit!

* * *

First Chauffeur—There's one thing I hate to run over, and that's a baby.

Second Chauffeur—So do I: them nursing bottles raise Cain with tires.

* * *

Mr. Martin—Mr. Miller is after findin' out why his cow went dry.

Miss Hogan—An' phwat was it?

Mr. Martin—His bye, Willie, milked the poor crayture wid wan of thim new-fangled, dust-suckin' machines!

* * *

"Colonel," asked the beautiful girl, "when was the most trying moment of your life?"

"It was when I went to my wife's father for the purpose of asking him to let me have her. He was very deaf and I had to explain the matter before twenty clerks."

* * *

Jack—It would please me very much to take you to the theater this evening.

Miss Heavyweight—Have you secured the seats?

Jack—Oh, come, now, you're not so heavy as all that.

* * *

As Jones wended his uncertain way homeward he pondered ways of concealing his condition from his wife. "I'll go home and read" he decided. "Whoever heard of a drunken man reading a book?"

Later Mrs. Jones heard a noise in the library. "What in the world are you doing in there?" she asked.

"Reading, my dear," Jones replied cheerfully.

"You old idiot!" she said scornfully, as she looked in at the library door, "shut up that valise and come to bed."

* * *

Magistrate—The man you ran down swears positively you were grinning like a fiend before the car hit him.

Trolley motorman—I was, your honor, but you will understand when I tell you, I was a chauffeur for three years before I got my present job and from force of habit I thought I could steer the car to avoid him after throwing the usual scare into him.

* * *

A new clerk in the Statistical Department asked the meaning of "deficit." "A deficit," answered Mac, "is what you've got when you haven't got as much as if you just hadn't nothing."

"Are you related to Barney O'Brien?" Thomas O'Brien was once asked.

"Very distantly," replied Thomas. "I was me mother's first child—Barney was th' sivinteenth."

* * *

Ruyters Kramp—You didn't even read this story that you turned down.

Magazine Editor—How do you know?

Ruyters Kramp—I pasted several of the pages together, and they weren't opened.

Magazine Editor—You don't have to eat the whole egg to know it is bad, do you?

* * *

There was a young man from the city
Who saw what he thought was a kitty
"Come here, little cat,"
He said with a pat—!!
They burned all his clothes—what a pity.

* * *

One day the office boy went to the editor of a country paper and said:

"There is a tramp at the door, and he says he has had nothing to eat for six days."

"Fetch him in," said the "ed." "If we can find out how he does it we can run this paper another month."

* * *

The missing link scratched his—or its—head, in deep perplexity.

"I'm certainly close to the people," mused the creature—or phase of development—"but where are the people? I don't see any!"

Which was quite true, for the people, though they were next, as one may say, had not yet arrived.

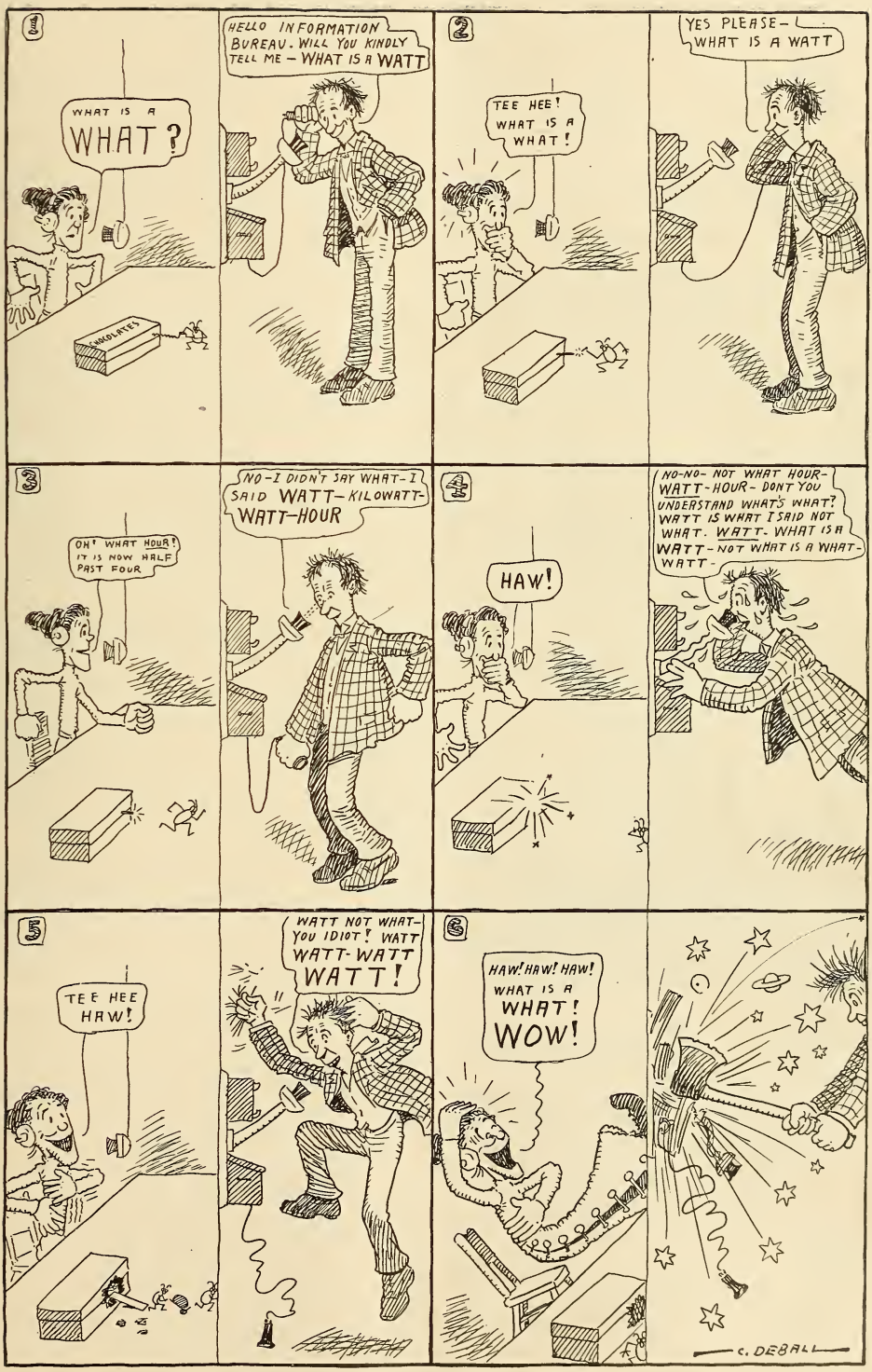
* * *

An American contractor visiting in England was inspecting some new construction work in company with the British contractor, and the latter was boasting of the rapidity with which English workmen could put up a building in case of necessity. "Why, look at this building," he said, "yesterday morning there was nothing on the ground but the foundation stones and now they are finishing the second story." "That's nothing," said his companion. "It very often happens in the United States that we start work on a building in the afternoon and next morning have to begin ejecting tenants for non-payment of back rent."

* * *

"I observe that you never pull anybody's political chestnuts out of the fire."

"No," answered the party leader and reorganizer. "My specialty is firing political chestnuts out of the pull."


1
WHAT IS A WHAT?
CHOCOLATES
HELLO INFORMATION BUREAU. WILL YOU KINDLY TELL ME – WHAT IS A WATT
2
TEE HEE! WHAT IS A WHAT!
YES PLEASE– WHAT IS A WATT
3
OH! WHAT HOUR! IT IS NOW HALF PAST FOUR
NO–I DIDN'T SAY WHAT–I SAID WATT– KILOWATT– WATT–HOUR
4
HAW!
NO-NO- NOT WHAT HOUR- WATT-HOUR- DONT YOU UNDERSTAND WHAT'S WHAT? WATT IS WHAT I SAID NOT WHAT. WATT- WHAT IS A WATT- NOT WHAT IS A WHAT- WATT-
5
TEE HEE HAW!
WATT NOT WHAT– YOU IDIOT! WATT WATT- WATT WATT!
6
HAW! HAW! HAW! WHAT IS A WHAT! WOW!
C. DEBALL

THE INFORMATION BUREAU

ELECTRICAL DEFINITIONS

Below are defined a few of the most common electrical terms. They are reprinted from month to month and will be of assistance in understanding the magazine text.

Accumulator.—See secondary battery.

Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.

Ammeter.—An instrument for measuring electric current.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt. The international ampere is the current which, under specified conditions, will deposit .001118 gram of silver per second when passed through a solution of nitrate of silver in water.

Ampere Hour.—Quantity of electricity passed by a current of one ampere flowing for one hour.

Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.

Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.

Brush.—The collector on a dynamo or motor which slides over the commutator or collector rings.

Bus Bars.—The heavy copper bars to which dynamo leads are connected and to which the outgoing lines, measuring instruments, etc., are connected.

Buzzer.—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.

Candle Power.—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.

Capacity, Electric.—Relative ability of a conductor or system to retain an electric charge.

Charge.—The quantity of electricity present on the surface of a body or conductor.

Choking Coil.—Coil of high self-inductance which retards the flow of alternating current. See self-inductance.

Circuit.—Conducting path for electric current.

Circuit-breaker.—Apparatus for automatically opening a circuit.

Collector Rings.—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.

Commutator.—A device on a dynamo shaft for gathering the current from the various coils of the armature and sending it out over the line as direct current. On a motor it takes current from the line and passes it on to the armature coils.

Condenser.—Apparatus for storing up electrostatic charges.

Cut-out.—Appliance for removing any apparatus from a circuit.

Cycle.—Full period of alternation of an alternating current circuit.

Dielectric.—A non-conductor.

Dimmer.—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.

Direct Current.—Current flowing continuously in one direction.

Dry Battery.—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.

Electrode.—Terminal of an open electric circuit.

Electromotive Force.—Potential difference causing current to flow.

Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.

Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.

Farad.—Unit of electric capacity.

Feeder.—A copper lead from a central station to some center of distribution.

Field of Force.—The space in the neighborhood of an attracting or repelling mass such as a magnet or a wire carrying current.

Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.

Generator.—A dynamo.

Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.

Insulator.—Any substance impervious to the passage of electricity.

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

Leyden Jar.—Form of static condenser which will store up static electricity.

Lightning Arrester.—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.

Motor-dynamo.—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa, or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.

Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.

Neutral Wire.—Central wire in a three-wire distribution system.

Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in height.

Parallel Circuits.—Two or more conductors starting at a common point and ending at another common point.

Polarization.—The depriving of a voltaic cell of its proper electromotive force

Potential.—Voltage.

Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.

Rheostat.—Resistance device for regulating the strength of current.

Rotary Converter.—Machine for changing high-potential current to low potential or vice versa.

Secondary Battery.—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.

Self-inductance.—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.

Series.—Arranged in succession, as opposed to parallel or multiple arrangement.

Series Motor.—Motor whose field windings are in series with the armature.

Shunt.—A by-path in a circuit which is in parallel with the main circuit.

Shunt Motor.—Motor whose field windings are in parallel or shunt with the armature.

Solenoid.—An electrical conductor wound in a spiral and forming a tube.

Spark-gap.—Open space between the two electrodes of a spark coil or resonator.

Storage Battery.—See secondary Battery

Thermostat.—Instrument which, when heated, closes an electric circuit.

Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

Volt.—Unit of electromotive force or potential. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

Volt Meter.—Instrument for measuring voltage.

Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.

Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.

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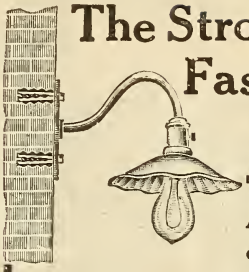

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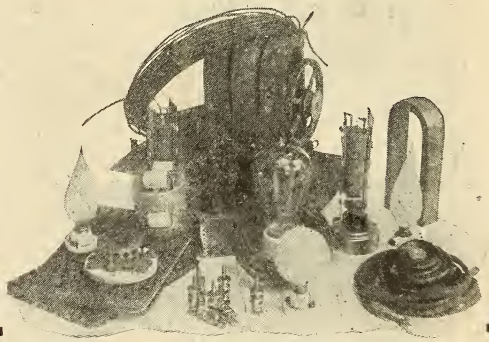

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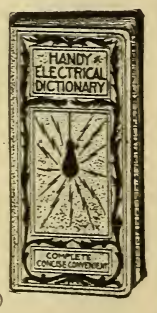

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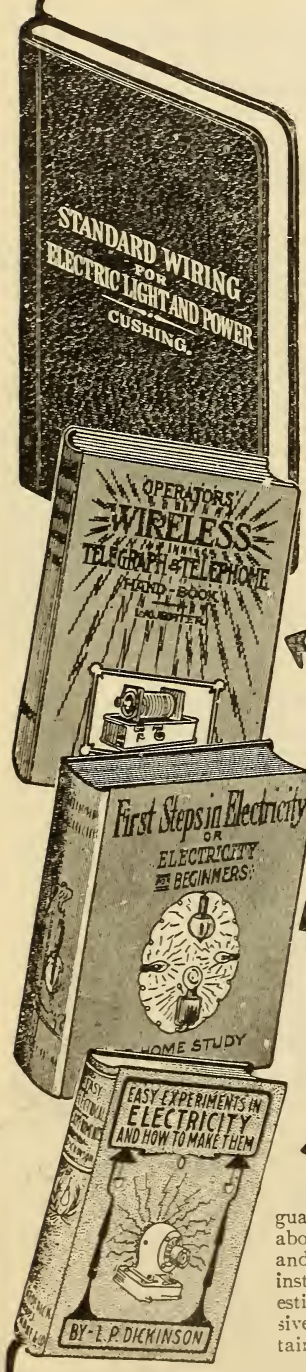
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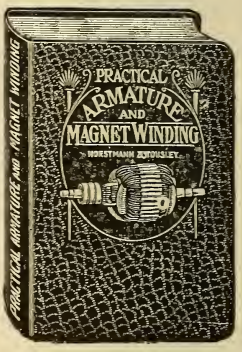

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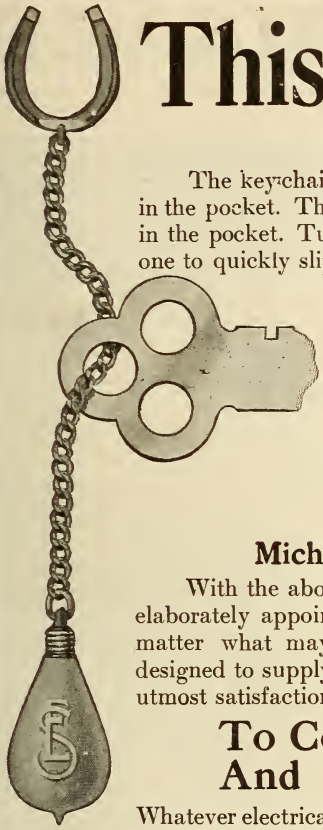

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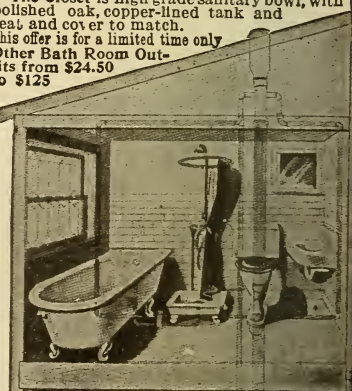

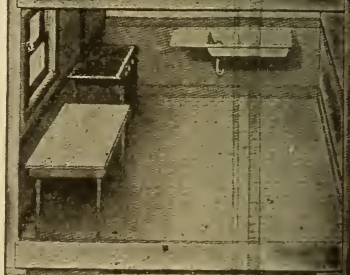

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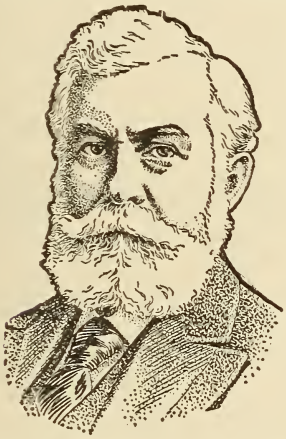

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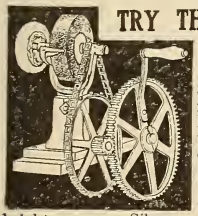

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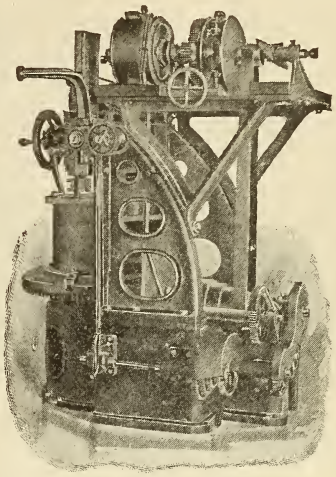

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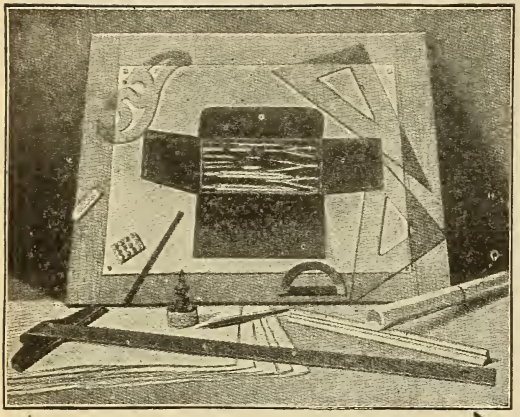

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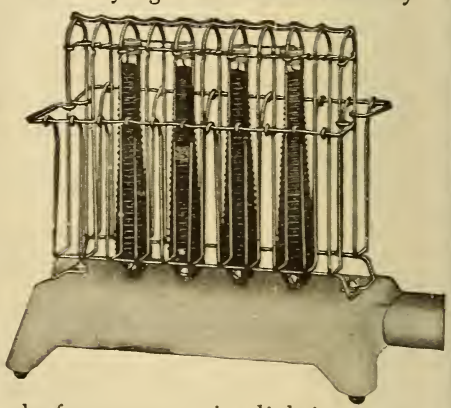

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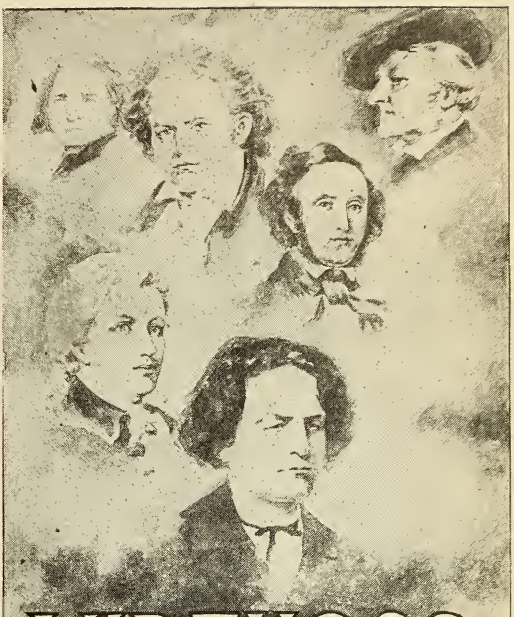

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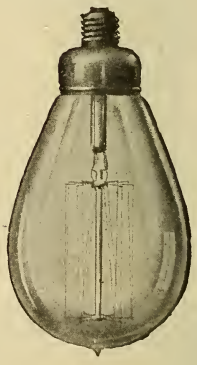
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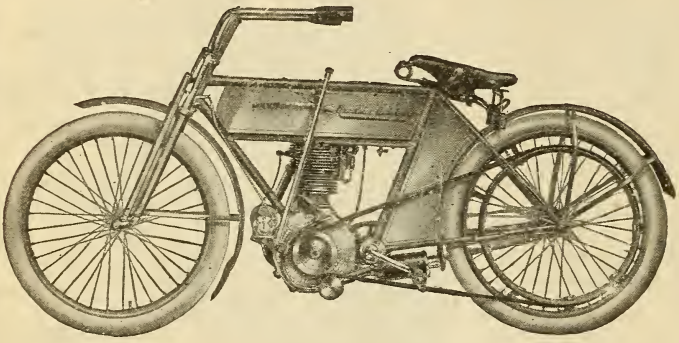

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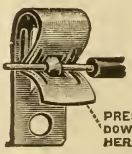

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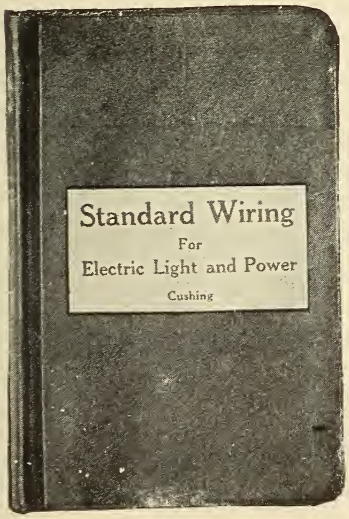

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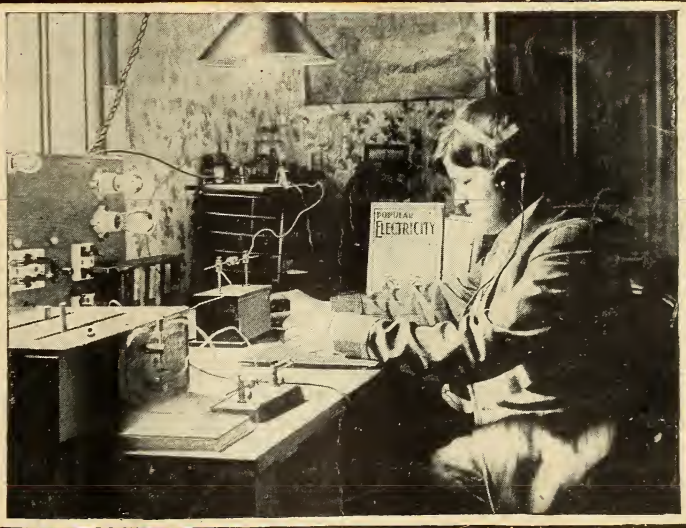

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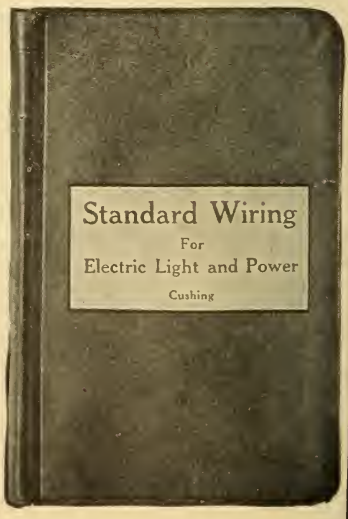

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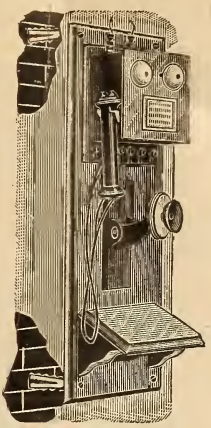

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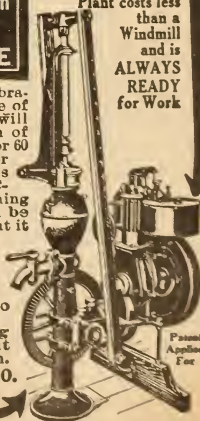

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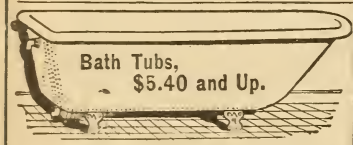

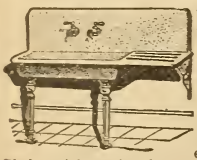

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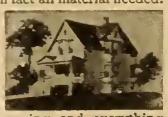
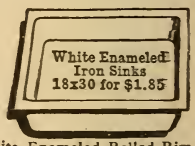


$180 buys a complete hot water heating plant for this 8-room house. 8 radiators, 300 feet of radiation, a 500 foot, cast iron, sectional heater, gold bronze, the necessary pipe and pipe fittings, radiator valves, covering, and everything required for an up-to-date job.



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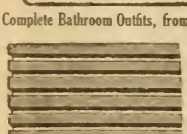

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IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. II SEPTEMBER, 1909 No. 5

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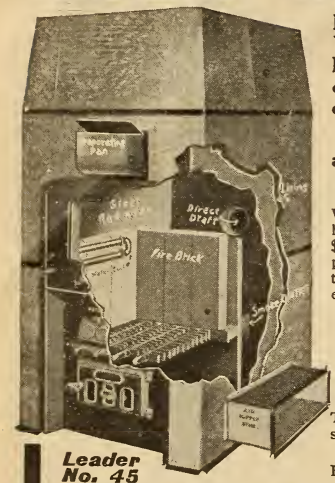

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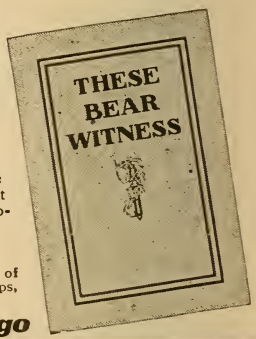

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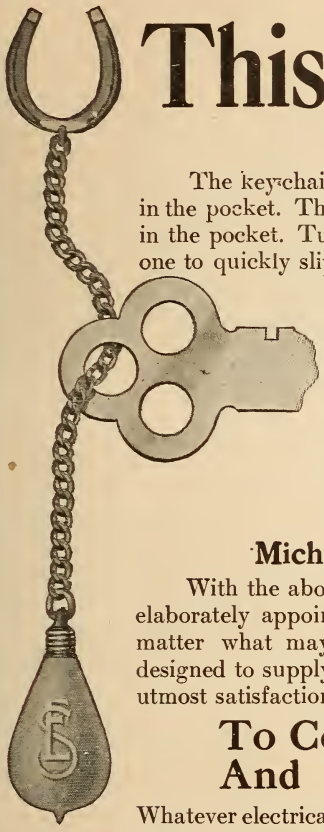

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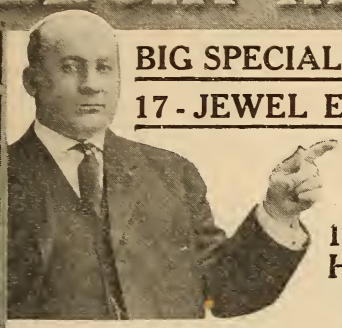

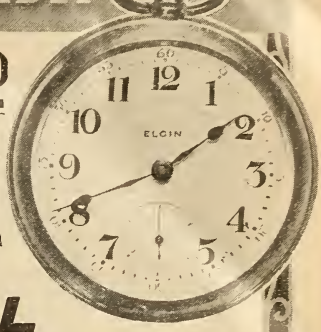

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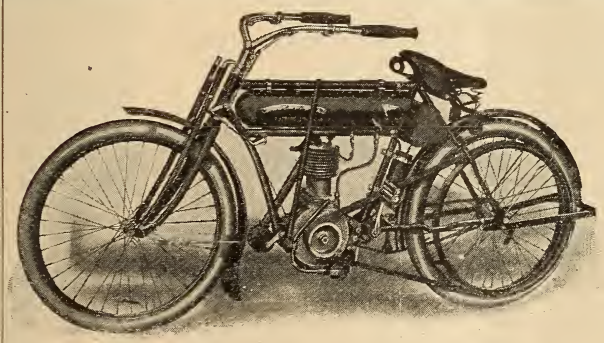

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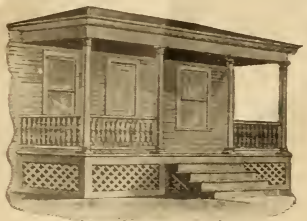

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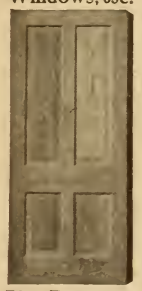

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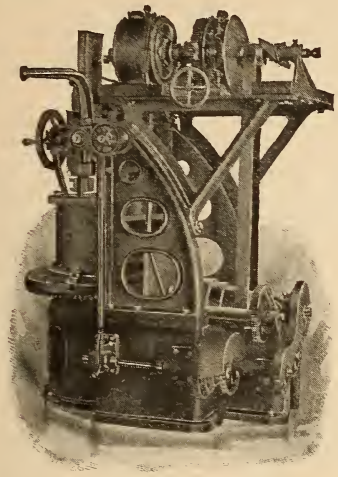

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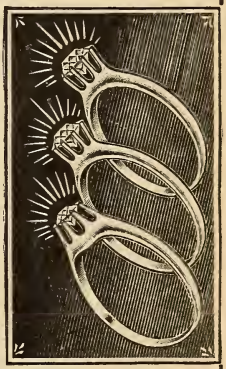

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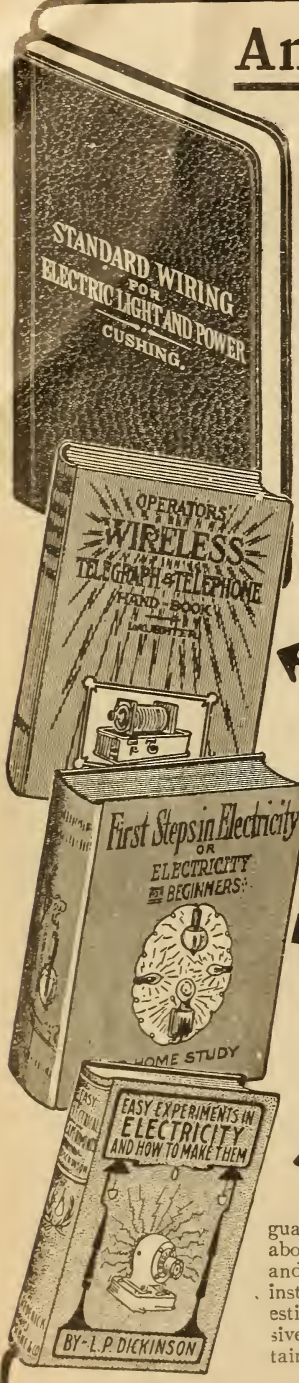
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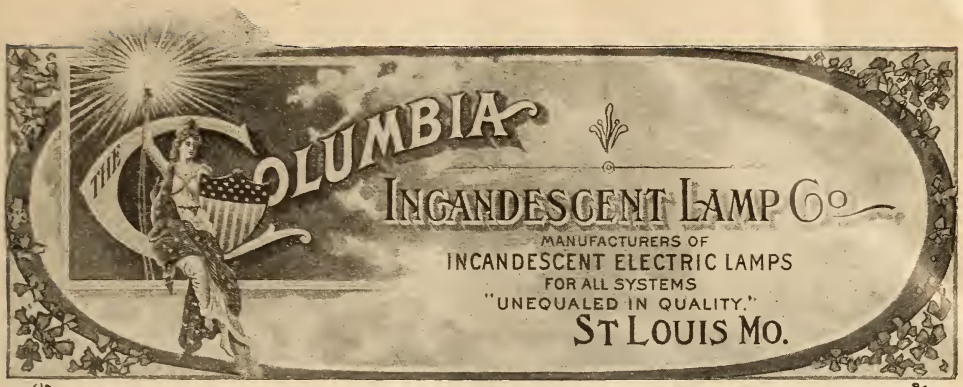

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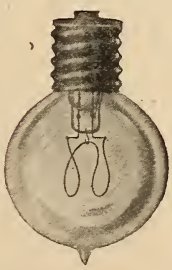

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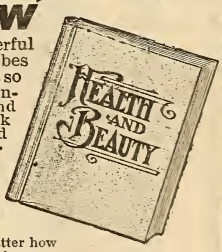

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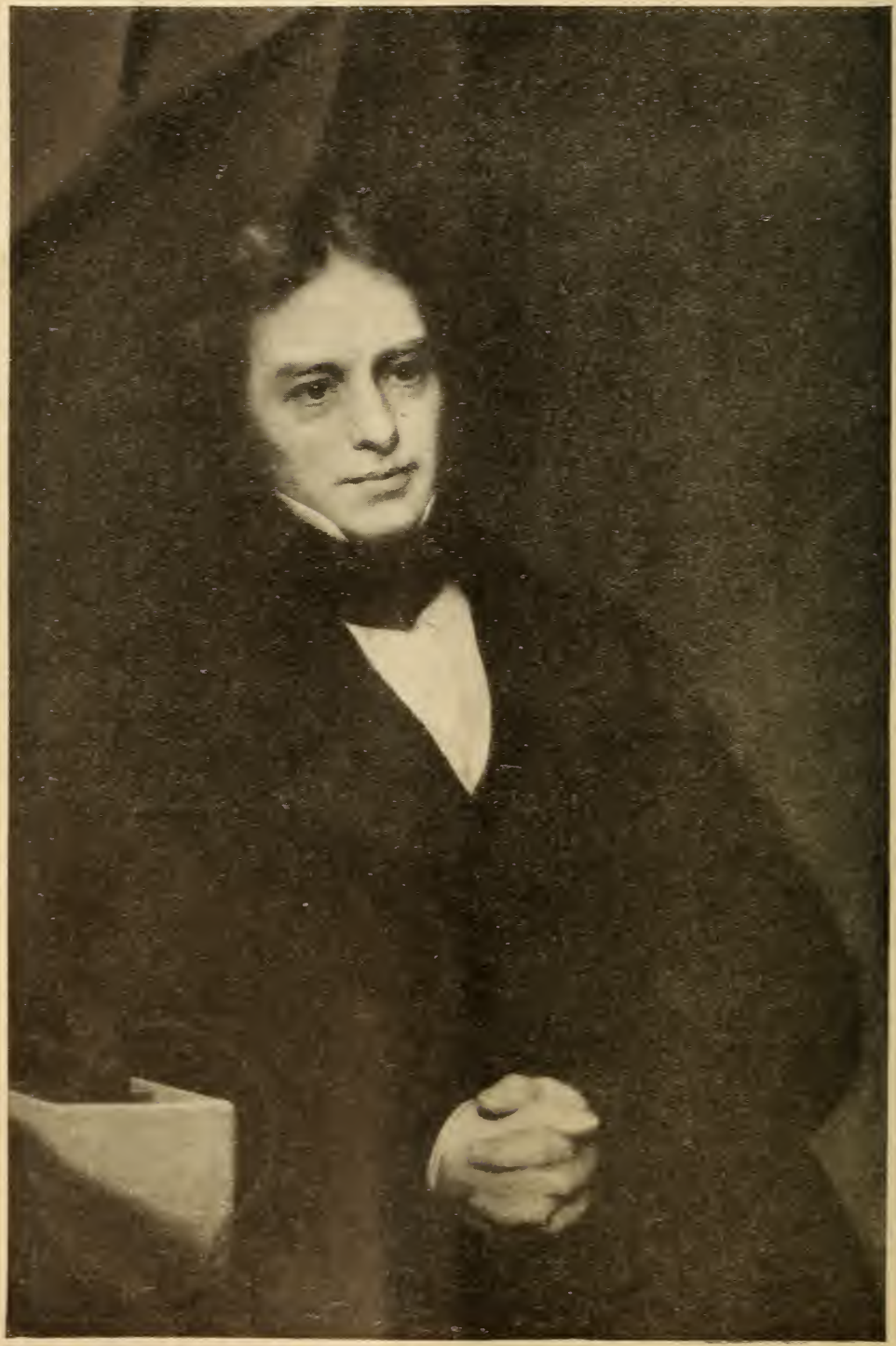

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POPULAR ELECTRICITY
IN PLAIN ENGLISH

VOL. II SEPTEMBER 1909 No. 5

MICHAEL FARADAY

The man who discovered the principle of the dynamo, upon which rests almost all electrical science and art as they exist today

Michael Faraday's work and discoveries were the immediate forerunner of the modern electric dynamo. In August, 1831, he performed a series of five immortal experiments, extending over a period of ten days, from which began a new era of applied electricity.

Upon the first day he obtained his first evidence that an electric current through one of two insulated wires, wound upon one-half of a soft iron ring, induced a momentary current in a second insulated coil on the other half of the ring, upon making and breaking the current, as shown by the deflection of the needle of a galvanometer connected to the second coil.

He next observed that with an iron cylinder having a helix of wire wound about it, and the iron cylinder being placed between the poles of bar magnets, that every time the magnetic contact of the bar magnets with the cylinder was made or broken, there was an electric current induced in the helix. This showed that electricity could be produced by magnetism in motion.

Upon his fifth day of experimenting he discovered the production of electricity by the approximation of a magnet to a wire. A cylindrical bar magnet was thrust in or withdrawn from a cylindrical wire helix, whereupon the galvanometer needle was deflected. This showed that the mere presence of a magnet near the coil was sufficient to induce a current.

Upon the ninth day he made a copper disk turn between the poles of a great horse-shoe magnet, the outer edge and the center of the disk being connected with a galvanometer by wires. The needle was deflected steadily as the disk turned in one direction, and as the rotation of the disk was reversed the needle was deflected in the opposite direction. This was the first dynamo.

The following day he found that a one-eighth inch copper wire drawn back and forth between the poles produced the same effect. This is the principle of the operation of the modern dynamo.

Michael Faraday was born at Newington, near London, September 22, 1791. At the age of twenty-two he was appointed an assistant in chemistry at the Royal Institute, London, the same year becoming private secretary to and attending Sir Humphrey Davy in a tour of the Continent. Upon his return in 1815 he was reappointed at the Royal Institute, and there commenced his great career of investigation and discovery in the field of electricity and magnetism. He died in 1867, one of the most honored men of all the group of early investigators to whom modern electrical art owes its being.

Elementary Electricity

By PROF. EDWIN J. HOUSTON, Ph. D. (Princeton)

CHAPTER XVII.—ELECTRIC SOURCES (CONTINUED). CHEMICAL ACTION.

The pressure or electromotive force produced by a frictional electric machine is greater than practically any other source, yet the quantity of electricity is extremely small. Frictional electric machines remained practically the only electric sources until about the beginning of the year 1800, when Alexander Volta, Professor of Physics in the University of Padua, discovered an entirely new source, that, although not capable of producing very high E. M. F.'s, yet could continue to furnish a greater quantity of electricity than any form of frictional or induction machine.

There is an interesting history connected with the discovery of this electric source. It appears that for many years prior to Volta's discovery, Luigi Galvani, a noted physician and professor of anatomy in the University of Bologna, had been in the habit of employing the hind legs of recently killed frogs as exceedingly sensitive electroscopes. These legs, prepared as shown in Fig. 75, were, according to some accounts, hung outside the window of his laboratory against the iron of a balcony. It so happened to Galvani's surprise that the nerves and muscles of the frog happening to be connected by the iron of the balcony the legs were at once set into strong convulsions.

It is strange in view of his knowledge of the fact that the passage of an electric current would produce such convulsions, that Galvani should not have recognized the fact that he had made the magnificent discovery of a new electric source. But Galvani had for many years been endeavoring to discover the cause of life, and being prone, as was perhaps natural, to believe that what he had observed was what he so greatly wished to discover, came to the incorrect conclusion that the convulsions were due to a vital fluid that, flowing out of the nerves of the frog and passing through the conducting path of the iron, was conveyed to its muscles. This was in the year 1786.

When Galvani published his discovery of a vital fluid, an immense enthusiasm was created throughout the scientific world, and his experiments were repeated by hosts of investigators.

Among the most prominent of these was Volta, who at first accepted Galvani's belief that the convulsive movement of the frog's legs was due to a vital fluid. Extended observations, however, soon led Volta to the conclusion that the phenomena were due not to a vital fluid but to electricity. Further investigations led him to believe that this electricity was produced by the contact of dissimilar metals, for he obtained the most pronounced twitchings when two dissimilar metals, such as zinc and copper, were employed; the zinc, placed in contact with the nerves and the copper with the muscles, while the other ends were held together in the hand.

A lengthy controversy followed Volta's announcement that what Galvani had discovered was not a vital fluid, but an entirely new electric source. Indeed, when it was afterwards recognized that a pair of dissimilar metals placed in contact at one of their ends and connected at the other end by a liquid capable of conducting electricity, and of acting chemically on one of the metals, would produce a current of electricity, a still greater difference of opinion arose as to the cause.

Volta believed, at any rate in his early experiments, that the electricity was produced by the mere contact of dissimilar metals, while others contended that the cause of electricity was chemical action. Without going any further into this question it is sufficient to say that while mere contact is capable of producing an electromotive force, yet chemical action is necessary to permit the electricity to continue to be produced, when dissimilar metals are connected at one set of ends and have their remaining ends connected by the kind of liquid referred to above.

Volta continued his experimental investigations and finally produced an apparatus that was named after him, the voltaic pile or column, and is now generally known as the voltaic battery.

Volta's original pile was constructed as follows: Two metallic disks, one of zinc and the other of copper, were placed on each other and separated from another set of zinc and copper disks by a disk of cloth or paper

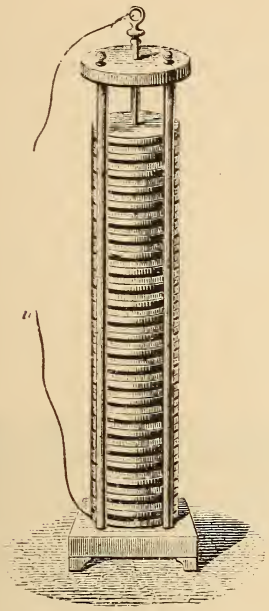


FIG. 113. VOLTA'S PILE

moistened by water containing a small quantity of sulphuric acid or common table salt. These separate sets were placed in regular order between the three vertical glass rods represented in Fig. 113, so as to form a cylindrical column or pile. The order was as follows: Zinc, copper, cloth; zinc, copper, cloth; zinc, copper, cloth, etc., from the bottom to the top of the pile. The different portions were then brought into contact with one another by pressure.

The pile or battery thus formed was capable of producing a constant flow of electricity that passed from a conducting wire connected with the copper plate on top of the pile, to a conducting wire connected to the zinc plate on the bottom of the pile. In other words, the wire connected with the end copper plate at the top of the pile was positive, and that connected with the end zinc plate at the bottom of the pile was negative.

Each combination of copper, cloth and zinc formed what is now called a voltaic cell. Since these cells were connected in series, it is evident that the battery will produce an electromotive force equal to the sum of the separate electromotive forces produced by each cell. Consequently, such a battery is capable of providing a fairly constant electric current that will continue to flow as long as sufficient zinc and acid remain.

In order the better to understand what takes place in the voltaic pile or battery we will first endeavor to see what takes place in a single cell. Such a cell is represented in Fig. 114, where a zinc plate (Z) and a copper plate (C) are dipped in water containing sulphuric acid. When the portions of the zinc and copper plates that extend above the surface of the liquid are connected as shown by the copper wire (M), an electric current passes through the liquid of the cell from the zinc to the copper plates, and outside the cell from the copper to the zinc. Since that portion of an electric source or

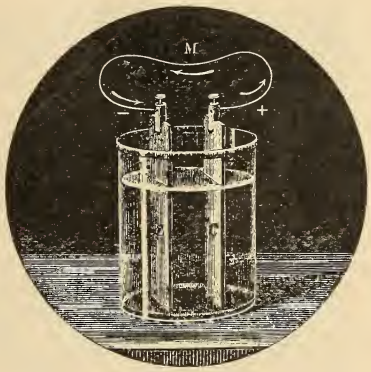


FIG. 114. VOLTAIC ELEMENT

circuit from out of which the current flows is positive, and that portion into which it flows is negative, the portions of the zinc and copper plates that are dipped into the liquid become respectively positive and negative, while the terminals that project above the liquid are respectively negative and positive.

A few definitions will aid in the explanations that are to follow. The zinc and copper plates are known as voltaic elements. The liquid in which they are dipped is called the electrolyte. To be capable of acting, an electrolyte must possess the power of acting, chemically on one of the elements and of conducting electricity. The portions of the plate that are immersed in the electrolyte are known generally as the positive plate and the negative plate, while the portions that

project outside the liquid are known as the electrodes or poles.

The following facts have been discovered respecting a simple voltaic cell consisting of zinc and copper immersed in dilute sulphuric acid. When the cell is open, that is, when the zinc and copper are not connected at their electrodes by the conductor (M), then, if ordinary commercial zinc is employed, a chemical action still goes on, the zinc plate is slowly dissolved and bubbles of hydrogen gas are given off from its surface. At the same time the heat generated by this chemical action of the acid on the zinc, which is practically the same as the burning of the zinc in acid, heats the entire mass of the electrolyte.

When, however, the cell is closed, or the terminals are connected by (M), bubbles of hydrogen are no longer given off by the zinc cell connected with the zinc of the adjoining cell. This leaves the zinc of the first cell and the copper of the last cell as the poles or terminals of the battery. The cells are, therefore, connected in series.

In the early days of the voltaic battery much difficulty was experienced by the unequal action of the acid on the zinc. In a properly arranged cell no chemical action should take place when the circuit of the battery is open, for then no regular current is possible. Unless, however, care is taken as to the employment of chemically pure zinc only, a chemical action of the acid on the zinc will occur whether the circuit of the cell is opened or closed. This action is known as local action and is due to impurities in the zinc, generally of small particles of iron, that form with the zinc minute voltaic couples that produce electricity in local circuits.

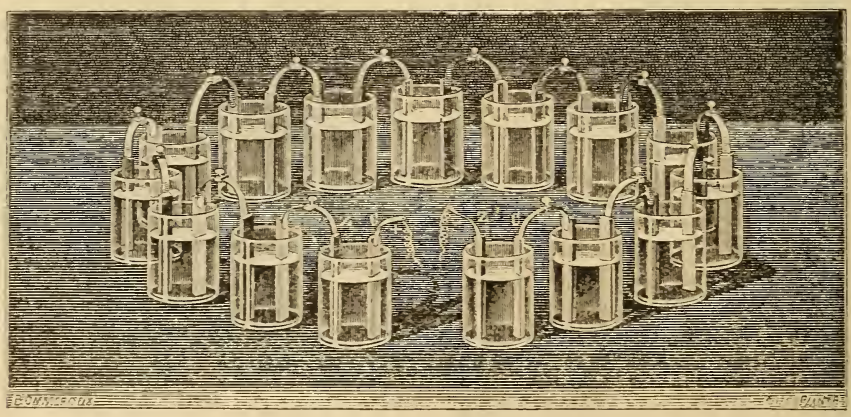


FIG. 115. FIFTEEN VOLTAIC CELLS CONNECTED IN SERIES

plate but all appear at the copper plate, while the energy produced by the burning zinc now appears in the circuit no longer as heat but as an electric current. It is evident, therefore, that the energy producing the current is the chemical potential energy of the zinc.

As will be seen, the elements of the voltaic cell, in this case the zinc and the copper, have opposite polarities below and above the surface of the liquid, those portions immersed in the electrolyte being in the case of the zinc positive, and negative in the case of the copper, while outside the electrolyte the copper is positive and the zinc negative.

In Fig. 115 fifteen separate voltaic cells are connected with the copper pole of each

The electricity, however, is not useful since it never reaches the external circuit. It merely attacks the zinc, uselessly burning it at the expense of a portion of the acid of the electrolyte.

Probably one of the most important improvements in the voltaic cell was the discovery that this local action could be avoided by what was known as the amalgamation of the zinc plate, effected by dipping the zinc plate into a weak solution of sulphuric acid and then rubbing its surface by a few drops of mercury, by means of a bit of rag tied to a stick. There is thus produced on the surface of the zinc plate a film of amalgam consisting of pure zinc combined with mercury. The particles of iron present in the zinc are

not dissolved in the mercury, but are carried off by the bubbles of gas and float in the liquid. There is thus produced a surface of practically pure zinc that is not acted on by the electrolyte until the circuit of the battery is closed.

In actual practice the electromotive force produced by a voltaic battery rapidly decreases after the battery has been for some little while on closed circuit. This is due to what is known as polarization.

Polarization is caused by bubbles of hydrogen that collect on the surface of the negative plate. Since hydrogen forms with zinc a voltaic couple, capable of producing a greater electromotive force than that produced by the zinc and copper, there is a tendency in a polarized cell to set up an electromotive force in the opposite direction to the electromotive force produced by the zinc-copper couple. This, of course, lowers the efficiency of the battery for the following reasons:

(1) The bubbles of hydrogen being non-conductors of electricity, increase the resistance of the cell, and, therefore, decrease the amount of current that flows through it.

(2) The oppositely directed electromotive force, produced by the hydrogen-zinc couple, being opposed to the E. M. F. produced by the copper, tends to decrease the effectiveness of the E. M. F. of the cell.

There are various methods by means of which the polarization of voltaic cells may be either decreased or entirely avoided. The most important of these are as follows:

(1) Mechanical methods, by which the hydrogen bubbles are brushed from the surface of the negative plate by a properly directed stream of air, so thrown against the plate, as mechanically to carry off the gas. Since gas bubbles will cling with greater strength to a smooth surface than to a rough surface, the plan is sometimes adopted of roughening the surface of the negative plate.

(2) Chemical methods, which consist in employing substances possessing great oxidizing powers, such as chromate of potash, permanganate of potash, oxide of copper, nitric acid, etc., that remove the bubbles of hydrogen by entering into chemical combination with them.

(3) Electro-chemical methods, which consist in employing what are known as double fluid cells, containing two electrolytes, and dipping the negative element, say copper, into a solution of copper sulphate so that instead of the hydrogen collecting on its surface, a film of metallic copper is deposited, thus absolutely avoiding objectionable polarization.

According to Ayrton and Perry, the electromotive forces in volts for the following different pairs of voltaic couples are:

Zinc, Lead	.210
Lead, Tin	.069
Tin, Iron	.313
Iron, Copper	.146
Copper, Platinum	.238
Platinum, Carbon	.113

The E. M. F. produced by the contact of any of the elements in this table is obtained by adding the successive E. M. F.'s. Thus, a couple of zinc and carbon would produce an E. M. F. of 1.09 volts.

(To be continued.)

Electricity an Insignificant Fire Hazard

From Jan. 1, 1908, to and including Dec. 15 of the same year, Chicago had 4621 fires, of which only 1.9 per cent. were reported due to electric wires or apparatus.

The following record covering a period of 135 days gives a means of comparison as to various causes of fires, electricity included:

Unknown	628
Careless use of matches	164
Overheated stove	109
Sparks from chimneys	100
Defective flues	88
Overheated furnace	60
Supposed incendiary	52
Spontaneous combustion	51
Explosion of gasoline	46
Thawing of water pipes	43
Explosion of gas	38
Electric wires	37
Gas jet	36
Oil lamps	35
Carelessness with candles	26
Hot ashes	26
Boiling oil	17
Cigar stub	12
Hot box	9
Christmas tree	5
Spark from locomotive	5
Explosion of chemicals	4
Plumber's torch	3
Incendiary	2
Lightning	1
	1633

Electricity is, according to these figures, a very infrequent offender and it is hard to understand why it is that the public press and unthinking people will almost always attribute the cause of fires of unknown origin to "crossed electric wires."

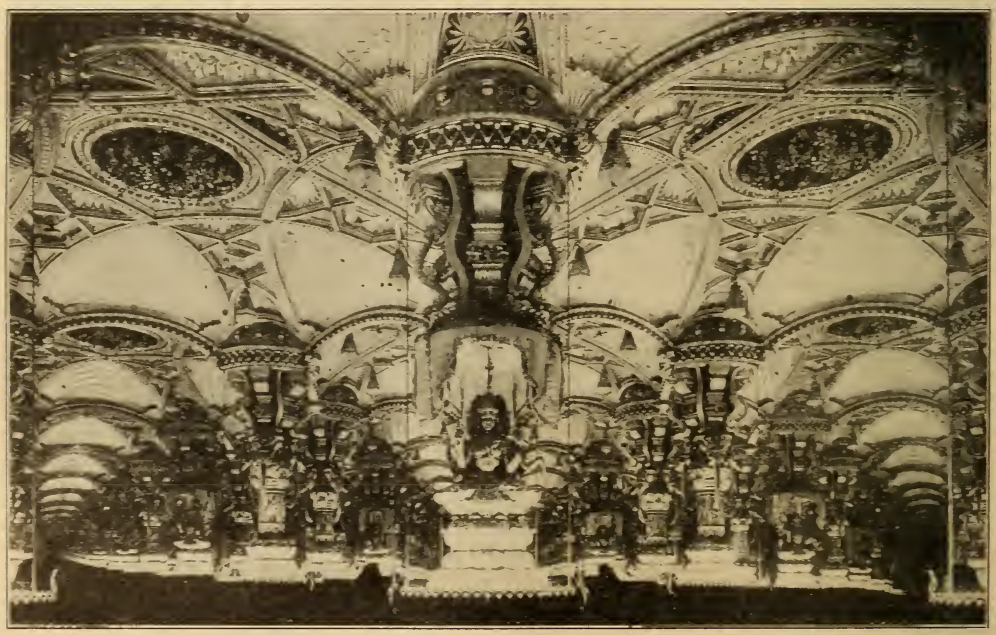
The Palace of Mirages

Novel utilization of electricity has been largely instrumental in giving to the pleasure loving city of Paris, France, its latest and in many respects its most ingenious amusement enterprise. This innovation that has aroused the enthusiasm of the French people—famous for their love of new sensations—is an institution known as "The Palace of Mirages." Fundamentally it is an elaboration of the theory of the apparent multiplication of objects placed between two parallel mirrors. In homely phrase it might be referred to as a development from the "crystal maze" familiar to all visitors to modern amusement parks. But this Parisian creation represents so high a development and embodies so much that is unique and interesting from an electrical and scientific standpoint that it is scarcely to be mentioned in the same breath as its more commonplace predecessors.

The primary feature of the equipment of this manufactory of illusions is found in six large fixed mirrors, attached to the walls of the building, and twelve smaller mirrors which are revolvable and which form the angles of a hexagon. The six main mirrors are the largest of their kind ever manufactured and measure, in each instance, 11 by 16 feet. The dozen smaller mirrors are mounted pivotally, enabling them to be turned simultaneously and it is this facility of manipulation which makes possible the presentation of three different and distinct schemes of decoration, each of this trio of decorative schemes being, of course, infinitely multiplied by reflection.

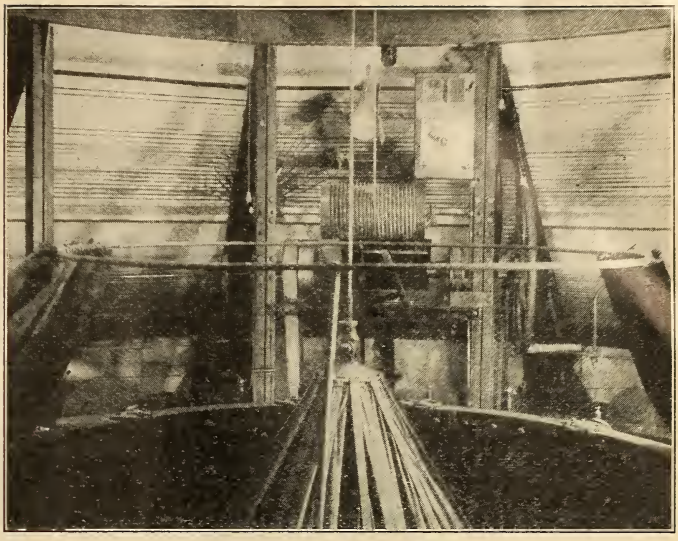
Stationed at the various angles of the hall, erected especially for this institution, are six rotary drums, each of these drums carrying six mirrors arranged in pairs and forming three angles of 120 degrees each. Each angle of the hexagon likewise measures 120 degrees. With this mechanical arrangement it is possible by giving the drums one-third of a turn to change the entire aspect of the hall. It is just here that one of the crucial functions of the electrical installation is manifest. The delicate, electrically controlled mechanism is such that the six drums can be turned either independently or simultaneously. When they are stationary, the mirrors of the drums complete the angle of the hexagon and are thus, to all appearances, part of the walls.

The decorative effects which are reproduced and multiplied by reflection are in



BEAUTIFUL PALACE OF MIRAGES

great part affixed to the mirrors and this circumstance brought about one of the problems of operation. The mirrors must be started, move and stop so gradually and carefully that none of the delicate decorations are dislodged or jarred from their proper position. The solution was found in the invention of a new type of brake. The drums above mentioned are actuated by a friction wheel and are stopped without shock by means of this special brake.



CANOPY MANIPULATING APPARATUS

The Palace of Mirages presents (by means of quick transformations effected in total darkness) three different schemes of decoration, representing, respectively, a Hindu temple, a forest and an Arabian palace—each seemingly limitless in extent, thanks to the aid of the mirrors. Although there are but three main "scenes" or settings, forty-five different luminous effects are rendered possible by the electric lights of which more than 2,500, involving lamps of all colors, are employed. As many as 1,800 of these incandescents lamps can be simultaneously illuminated and in the final effect in the last scene the mirrors create the illusion of 64,800 lamps. Not only are stationary incandescents used but portable or moving lamps are employed in the simulation of birds, butterflies and other aerial travelers.

ELECTRICAL CONTROL OF PALACE OF MIRAGES

The system of electrical illumination is supplied with a direct current of 500 amperes and 110 volts. The 45 different luminous effects above mentioned are controlled by means of a special switchboard with 45 keys. A particularly novel feature of the electrical equipment is that provided for the manipulation of a great decorative canopy which is utilized in the forest scene in order to convey to the spectator the illusion of a continuous leafy bower. Under electrical impulse this huge, painted, flexible fabric slides through a central ring and expands until it forms a canopy over the entire central hall. For the speedy manipulation of this tent-like covering there are employed numerous counterweights and a network of wires.

According to the estimates of Mr. Lewis B. Stillwell, presented before the American Institute of Electrical Engineers, the Niagara Falls hydro-electric plants, during the year 1908, saved the equivalent of more than a million tons of coal.

Card Indexing the Country

By WALDON FAWCETT

The thirteenth national enumeration of the population of the United States which will be made next year may be termed, very appropriately, the "electrical census." This nick-name is deserved because of the extensive dependence which will be placed upon electrical energy for carrying out this gigantic job of figuring and by reason of the invention of some marvelous electrically operated machines for conducting the statistical work by mechanical means. Indeed, there is no precedent, either in governmental activities or in the modern business world, for such widespread utilization of the magic current for clerical and kindred work, and the fact that Uncle Sam relies so largely on this form of power in the biggest undertaking in which he is called upon to engage, is, to say the least, highly significant.

The decennial counting of every man, woman and child in the republic, for which the U. S. Congress recently appropriated the sum of $10,000,000 will not take place until the year 1910 but very active preparations have been in progress for some time past for this unique enterprise which will engage the services for long or short periods of upward of sixty thousand regular and temporary employees of the government. Most important of those preliminaries has been the invention by the electrical and mechanical experts of the United States Census Bureau of a remarkable series of recording and tabulating machines which, under electrical impulse, perform statistical work that would require thousands of human hands. To be sure, most of the new machines require a man or woman operative (although some are entirely automatic in action) but this does not mean that they are not economical, for each electrical toiler accomplishes as much, in a given time, as would scores of clerks, figuring with pen or pencil in the old-fashioned way.

The next Federal Census, as becomes the foremost job of accounting that befalls a progressive government, is to be taken on the card index plan—"card indexing the country," the project has been termed—with an individual pasteboard for each and every inhabitant of the United States. It is in preparing and handling these personal records, probably ninety odd million in number, that the newly perfected electrical machines find their chief functions. Just here it should be explained that the facts concerning the age, color, sex, nationality, etc., of an individual are not penned or typewritten on the card reserved for him as would be the case in any ordinary card index system. Instead this biographical data that is essential to the compilation of an informative census is recorded by means of holes punched in the card. The number

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OPERATING ELECTRICAL CARD INDEXING PUNCH

and locations of these round punctures carry significance. In other words, the positions of the holes on the surface of a minutely ruled and blocked card indicates to any person conversant with Census Office practice all the needed information relative to the individual who is represented by the card. No writing whatever is necessary.

Perhaps the most wonderful of the new electrically muscled census machines is the card punching apparatus, the purpose of which is to transform blank cards into biographical records in accordance with the system above described. The machine has a keyboard very similar in appearance to that of a typewriter but with 240 different keys instead of less than one-sixth that number. Each key when depressed records one fact. The keys are not only inscribed to indicate their functions but the main groups of facts are differentiated by keys of different colors, thus guarding against confusion. The machine, in its operation, differs from the typewriter in one important respect. In the familiar type of writing machine a record is made—that is a letter or figure is printed—every time a key is depressed and if a mistake is made it must be crossed out or corrected with some inconvenience. In this novel new form of recording mechanism, however, the operator instead of punching one hole at a time, can depress as many keys as are necessary to record the biography in hand and after all the lines of inquiry have been thus disposed of, a button is pressed bringing an electric motor into play and all the holes are punched simultaneously without further effort on the part of the operator.

This latitude of operation has the advantage that each key being independent of all the others can be released at will without a hole being punched or any fact recorded. Thus the operator before turning on the electric current for the punching operation, can look over the depressed keys to make sure that the chronicle is correct and if an error be discovered the wrong key can be released and the error rectified before any punching is done, thus effecting a great saving both in cards and labor. An average operative can by means of one of these new machines punch more than 4,000 cards per day, as compared with perhaps 900 cards per day with the old-style hand punch which this new invention has superseded. Moreover, not one per cent of the cards are spoiled in the course of the operation.

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ELECTRICAL TABULATOR

While the operator of one of these new punching machines is recording the distinctive facts concerning the individual whose card is in course of preparation, the machine is automatically performing a supplementary operation of almost equal importance—namely applying by means of a "gang punch" a mark common to a considerable number of cards, for instance, all the cards for a given city, county or state—cards that would obviously be duplicates of one another in so far as their geographical data is concerned. As further evidence of the versatility of this new card punch, it may be mentioned that automatic

counters are attached to the keys and thus every time a hole is punched the fact is duly recorded on a dial. This adjunct is exceedingly valuable in census practice since it will make possible the announcement of important totals as soon as all the cards have been punched. There are a dozen of these dials on each punching machine and once the ninety million cards, representing the country's population, have been put through the punching process the officials can, by consulting the dials, learn not only the exact total of the country's population but the numerical strength of the grand divisions of the population as to males, females, native, foreign, white, colored, married, single, etc.

Finally, the cause of economy is furthered by the circumstance that there is no hand feeding of cards in the new machine. The operator places about 600 cards—sufficient for the average "run"—in a magazine at the back of the machine; sets up in front of her in an automatic "schedule turner" the sheet of returns received from a census enumerator in the field, and leaves the rest of the work to the machine. All she has to do is to touch the keys as above described. When the keys have been depressed as desired the operator touches a bar similar to the space bar of a typewriter and the motor with one complete revolution punches all the holes in the card; gang punches the card; records all the required facts on the automatic counters, and turns the schedule to the next set of facts. At the same time the punched card is fed out automatically to a magazine in front of the machine and a blank card is fed in from the rear to undergo a similar operation, after which the motor stops automatically.

Invented to supplement the work of the machine above described, particularly in compiling combinations of facts that involve more or less intricate records, is the lately perfected electric tabulator. This tabulating machine is in the form of a heavy cabinet from the front of which extends a movable arm or lever attached to the outer extremity of which is a "pin box" containing a needle for each possible hole in a card. When the pin box is brought down over each card in turn, that is fed into the machine, the needles which meet the unpunched surface are repressed while those that pass through holes make an electric contact below and by means of relays cause one or more counters or dials to register. The complement of dials are connected with an automatic recording and printing system, suggestive in its operation of the familiar stock ticker, and thus the totals compiled by the tabulator are printed on tapes.

The form of tabulator above described is semi-automatic but requires the constant attention of an operative when in service. However, the census experts are now at work on a tabulator designed to be wholly automatic in its action, which will feed cards from a magazine and receive them into another magazine after the fashion of the new card punch. Electric motors of one-half horse power are employed for the operation of the new census machines and great numbers of these will be in simultaneous operation when the work of compilation is in full swing.

Memorizing Ohm's Law

"E" stands for the pressure
Which we are taught to use,
Divided by "R", for resistance,
Will give us "C," the juice

$$\frac{E}{R}=C$$

"C" is "E divided by R,"
With this we don't get very far,

$$C=\frac{E}{R}$$

But "E" is "R times C," you see,

$$E=R\times C$$

And "R" is "E divided by C."

$$R=\frac{E}{C}$$

"W," watt, is "Current times
Electromotive force,"

$$W=C\times E$$

And "seven forty-six" of them
The "Power of a horse."

$$746=H.P.$$

—Telegraph Age.

Rapid Transit and the Round City

All large cities tend to grow round in form unless there are natural restrictions to such growth. The cause of this tendency is the necessity of concentration in a comparatively small area of the great interests in the world of trade, where a large portion of the city's inhabitants find their daily occupation. The agent which makes possible this state of affairs is rapid transit or more strictly speaking electric rapid transit, for without electricity subways and elevated roads would be practicably impossible. Without swift and ample transportation facilities great cities of today would be composite in character, consisting of a number of business centers instead of being a single unit built up around one great center.

Problems of transportation in a city of two or three millions of inhabitants are the most serious with which the city has to contend, and they result from one cause—that little congested district. The lateral limits of this congested district are restricted to a half a mile or even a quarter of a mile from the center. Then, when necessity demands, the city at this point grows straight up in the air, ten, twenty, even forty stories. In this beehive a million people may work every day. Every morning they must be brought into it, every evening taken home, and a large part of this coming and going occurs within a period of an hour and a half night and morning.

Outside of a zone extending two or three miles from the center, and which is served principally by the surface cars live the people who are affected by rapid transit. They live in the outskirts of the city or in suburban homes, where there is light and air. Their station in life permits them to do this. But they object strenuously to consuming more than 30 or 40 minutes in going or coming. As the city grows it is continually reaching out and out to provide dwelling places for the new thousands. It it should grow straight out in one direction and try to become a long city there would come a time when the distance in this direction would become so great that the time limit in going from and coming to the city would be reached, also the point would be reached when the transportation company could no longer maintain the five cent fare, for people carried above a certain distance are carried at a loss which must be made up for by the short haul passengers. Therefore transportation facilities must be extended out in all directions toward these limits and the city becomes a circle.

A peculiar state of affairs exists in New York city. It has tried its hardest to become a long city. Manhattan and the Bronx, occupying as they do a long point with the Hudson River on one side and East River on the other, tend naturally toward this condition. So the city started out to grow with the evident intention of overthrowing this law of great cities. First the surface cars took the people to the point where lies the greatest activity. They were soon overwhelmed. Then the elevated roads were built—four long parallel lines of them —and they likewise could not handle the traffic. Then came the famous subway, and it is now crowded to its utmost and more people clamoring to live farther out. The limit of this long city is reached, and slowly and surely, with its constantly growing and magnificent system of great bridges and tunnels, new rapid transit outlets are being made in all directions to be filled up with a rush by the home-seeking public, and the New York of the future will be round.

Did you ever attend a great base-ball game, and go early to watch the crowd arrive? If you did you may, in a manner, watch the growth of a great city. First come the "general admissions" and fill up the most desirable seats in the bleachers nearest the field. As the time draws near for the opening of the game the bleachers are filled up to the very top and to the farthest end. Meanwhile the grandstand is filling up. Now our little city is triangular in form with the congested district near the apex.

Still thousands are clamoring for admission. So the late comers are allowed to fill up the field along the side lines, and they crowd in along a narrow strip on each side extending farther and farther down. They want to fill in the whole end of the field but at first they are not allowed to do so, unless the game is an extraordinary one. Then they are not to be denied. A policeman or two gives away here and there along the line. A little tongue of people shoots out here and another there toward the center of the field. These flying wedges become surging crowds. In a few minutes they fill up the entire back part of the field in a neat semicircle and our little round city is complete.

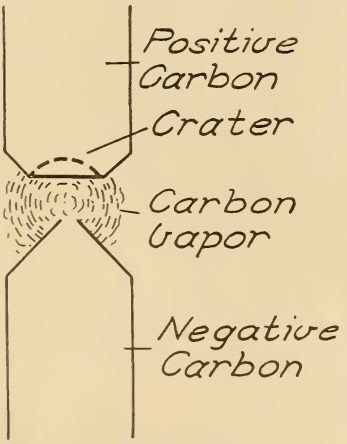
So it is with the building of a great city. Conditions demand a common meeting point or center. Rapid transit makes possible this single center instead of a number of isolated ones. The quickest and easiest way to reach this center is along radial lines and the city becomes round.

How Light is Made

We are all more or less familiar with the effects of different sources of electric light. But how many are able to explain the principles of the four most common kinds of electric lights? There are the arc lamp, incandescent lamp, the mercury vapor or Cooper-Hewitt lamp and the Nernst lamp. What are they and how do they make light?

THE ARC LAMP

Fundamentally the arc lamp consists of two carbon rods inserted in a break in the electric circuit and separated a slight distance so that the current jumps across the break and continues on its way. The carbons are first touched together to complete



ACTION OF THE ELECTRIC ARC

the circuit and start the current flowing, then they are drawn apart, the current continuing to flow across the gap through a conducting vapor of carbon which is formed. This is the principle. There are a great many accessories to the arc lamp, however, which are provided for automatically maintaining the proper distance between the carbons. These are operated by electro-magnets affected by the current flowing through the arc lamp circuit.

There are many interesting features in the carbon arc of which the casual observer never dreams. For instance the two carbons do not burn away alike. The positive carbon, which is generally made the upper one in the lamp does not burn away evenly but is hollowed out at the end like the crater of a volcano. The lower or negative carbon on the other hand soon forms a point and is consumed very slowly.

It is from the crater that most of the light is emitted, not from the incandescent vapor of the arc. The temperature of this crater is 3500° C., or 7420°F. which is the temperature of melting carbon, the most refractory substance known. This crater of a carbon arc is literally "the hottest place on earth" and will melt any known substance.

The light emitted by the arc crater approaches very nearly that of sunlight, containing all the colors of the spectrum in nearly sunlight proportions.

The ordinary direct current open arc consumes about 10 amperes at 45 volts, or 450 watts. This means that in the little crater, a fraction of an inch across, there is constantly being used up over one-half of a horse power of energy.

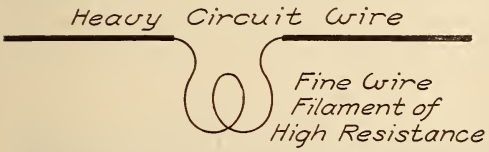
There are various types of arc lamps now on the market. They are made for alternating and for direct current, open and enclosed, for series and for multiple operation, with solid and with special cored carbons (the flaming arc is an example of the latter), but they all embody the principle of the current jumping across a gap between the carbons.

It may be interesting to know that Sir Humphrey Davy, in 1808, made the first arc lamp. This was before there was a commercial dynamo even. He used a galvanic battery of 2000 cells. The arc lamp did not become a commercial proposition, however, until the dynamo was developed.

THE INCANDESCENT LAMP

The incandescent electric lamp is perhaps simplest of all and the public is the most familiar with it. It was found in the beginning that electricity flowed more easily through large wires than through small ones, the latter presenting a greater resistance. To force current through a small wire takes energy which is expended in the form of heat. Edison first applied this principle to the incandescent lamp. To do this it was necessary to make the resistance element of carbon in the form of a fine filament. A wire of copper or iron that fine would melt

like wax from the heat developed by the current trying to crowd through it. The carbon filament must even be enclosed in a bulb from which the air is exhausted, for if it were operated in the open air the oxygen combining with the carbon at the high temperature would very soon destroy the filament; in other words it would be oxidized or burned up.



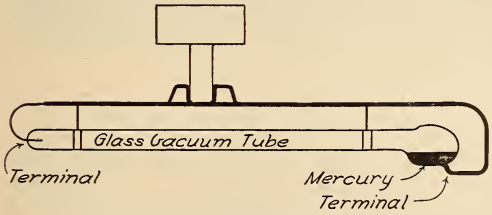
PRINCIPLE OF THE INCANDESCENT LAMP

The incandescent lamp is, therefore, nothing more than a very fine filament of high resistance inserted in an electric circuit and enclosed in a vacuum bulb for protection. The current passing through the filament heats it up to incandescence and it emits light.

There are many different types of incandescent lamps, such as the carbon filament, metallic filament, tungsten, tantalum, etc., the newer types, such as the tungsten, having a higher efficiency, owing to the fact that they can be operated at a higher temperature.

MERCURY VAPOR LAMP

Most of us have seen the long glass tubes which emit a greenish or bluish light and which gives one's face a peculiar ghastly tinge. These are mercury vapor lamps or



PRINCIPLE OF THE MERCURY VAPOR LAMP

Cooper-Hewitt lamps, as they are often called, after their inventor Peter Cooper-Hewitt.

The mercury vapor lamp consists of a long glass vacuum tube in one end of which is a little cup containing mercury. One terminal of the electric circuit enters this mercury; the other terminal enters the other end of the tube. By tilting the tube and agitating the mercury the latter is partially vaporized and the tube is filled with the mercury vapor. This vapor then conducts the current across from one terminal to the other through the tube, but in passing it heats the particles of mercury vapor to a high state of incandescence, emitting the peculiar light mentioned. This is the principle of the mercury vapor arc although there are modifications such as devices for starting the arc without tilting the lamp, etc.

NERNST LAMP

An interesting type of incandescent lamp is known as the Nernst. It has a glower which is neither carbon nor metal and this glower has first to be heated by external means before the lamp will light up. The glowers are made of a mixture of "rare earths", something like those used in the mantels of Welsbach burners. They are inserted in the circuit as in the case of the incandescent lamp, though no protecting bulb is necessary. But they do not heat up at once as the current cannot flow through them while cold. So a wire from the main circuit, very fine and of high resistance, is wound around them. When the current is turned on, this fine wire heats up as in the case of the incandescent filament and in doing so, soon heats up the glowers to a temperature at which they will conduct electricity. The current then flows through the glowers and maintains them at the temperature of incandescence. Meanwhile the fine wire heating coil, being no longer needed, is automatically cut out of the circuit.

Electricity in Kodak Films

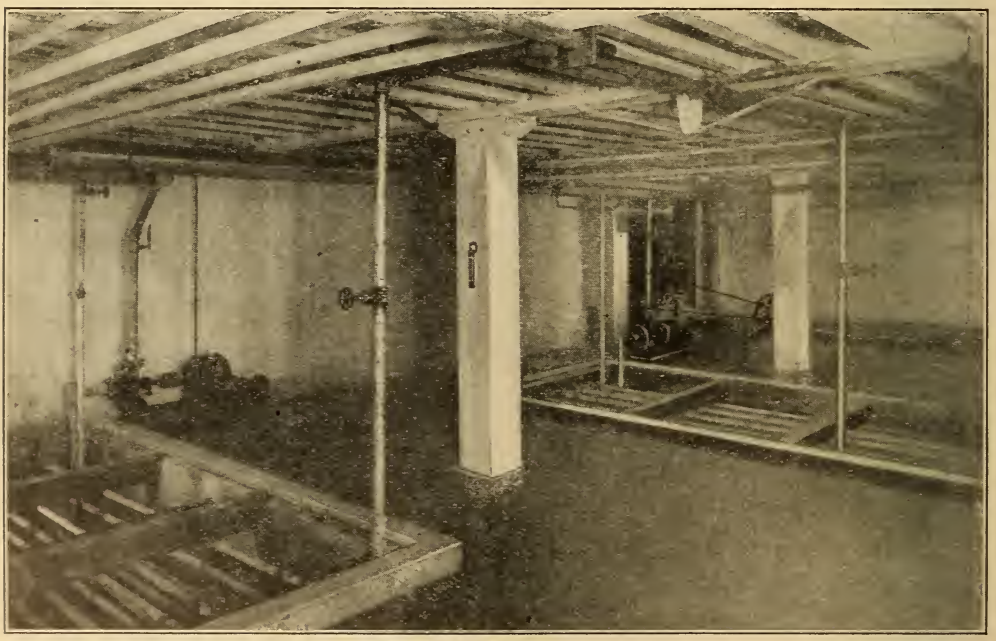
Some of the hitherto unexplainable tricks played upon photograph films have been found to be caused by static electricity. The band of celluloid that serves as foundation for the layer of gelatinobromide becomes electrified by contact with the black paper that protects the roll against light, or simply by contact with the next sensitive layer in the roll, so that in certain conditions there are actual electrical discharges that leave their traces on the image, after development, in the form of branched or zigzag lines.

A warm and dry atmosphere seems to favor the accident, which occurs notably when the operator removes the roll from the apparatus; if the spool is partly unrolled he squeezes it lightly and thus gives a slight motion of rotation to the interior coils; friction then determines the phenomenon, and the harm is done.

Electrical Curing of Meats

In Cleveland, Ohio, is to be found a model plant for the curing of meat by electrical process; the first of its kind. The purpose of the plant is to demonstrate the practicability of the method, and in that respect it is creating somewhat of a sensation.

The company's object in erecting a plant of 50 tons capacity of cured meat per month, was not for the purpose of engaging to a large extent in the packing business, but



MEAT CURING VATS WITH ELECTRIC CIRCULATING PUMPS

that the packers might be able to see the practical side of a complete plant—and have demonstrated to them by actual trial on a commercial scale that electricity fits into the curing of meats just as perfectly as it has into every other enterprise to which it has been applied with revolutionizing effect. The introduction of electricity to the curing of meats adds no complications, but simplifies the old method. The result is a saving in time, labor, pickle, cooperage and floor space.

Vats about 14 feet long, four feet high, and four feet wide, are substituted for the hogshead and barrels as seen in the packing house of today. The meat to be cured is placed in layers in these tanks, each layer being separated by wooden racks. Layer upon layer of meat is laid in until the vat is full, each vat holding approximately 5,000 pounds of meat. The vat is then filled with pickle (no particular formula being required, as no change in a packer's formula is necessary). The electric current is turned on. The circulating pump is started, and, if the meat be bacon, four days are required to produce a perfectly mild cured meat, ready for the smoke, No handling of the meat is necessary during the process of curing and the same is true whether the meat be bacon in cure four days, hams in cure 30 days or beef 20 days. No changing of meat from tank to tank is necessary and no pickle is wasted.

The same pickle is now used with which operations were started on March 17th, 1909, there having been cured to date 10 batches aggregating 5,000 pounds to the batch, and the pickle is as good as ever. The saturation is kept up by adding ingredients to the pickle in the cooling tank outside the vat from time to time as needed. The purity and lasting qualities of the brine is attribu-

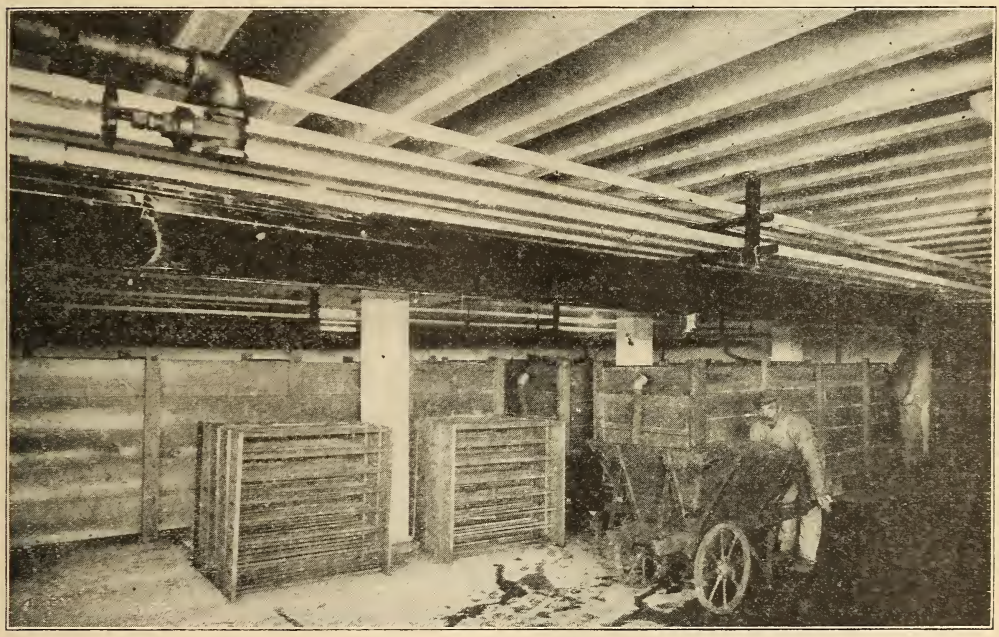
table to the purifying influence of the electric current.

The vats in the company's plant are arranged in sections of from one to as many as may be required for hams, beef and bacon, each section having its own formula of brine. An overflow tank with cooling coils in it takes care of the circulation of each section. One electrical centrifugal pump and one overflow tank will cool the brine and handle the circulation for a section of 10 tanks or more.

The necessity for circulating the brine arises from the fact that a system of electrodes is placed at the ends of each vat, forming the poles from which the current travels through the brine and meat, alternating from pole to pole 7,200 times per second. This raises the temperature of the brine, and it is therefore necessary to circulate it through a cooling vat. The brine is thus constantly being returned to the vat at the proper temperature by the aid of a contrifugal pump.

Electrical control consists of one transformer for each 20 vats, one switch and a regulating rheostat for each vat, mounted upon a switchboard. These devices are located in the engine room and are under the control of the engineer.

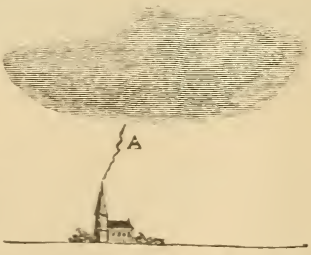
It took years of experimenting to bring the electric process of curing to a practical point. All preliminary experiments were carried on at a large packing house in Cincinnati, Ohio. It was with meat cured at this plant that many features valuable to the packer were discovered, principal among them that of the keeping qualities. It has been clearly demonstrated that the meat will not skipper, due to there being no impurities in the meat, after it comes from the electric bath, in which the skipper fly may nest. Tests have proven that bacteria, which cooking does not appear to destroy, are annihilated by the electric current. The company has in its offices, on exhibition, a piece of bacon cured in five days by electric process, shipped to Hon. Wm. Canada, U. S. Consul, Vera Cruz, Mexico, by express, in a slatted box so that flies could enter, but barring rats and mice. This shipment was intended to make a quick express trip but got lost in transit and remained in that hot country four months. It finally reached Consul Canada, he examined it, found it O. K. and reshipped it to the sender. It arrived in Cincinnati, was opened by a United States Inspector who passed it as being in good condition.



MEAT CURING TANKS—CAPACITY, 5,000 POUNDS

When Lightning Strikes

In studying the actions and vagaries of lightning it must be remembered that a mass of vapor, which we call a cloud, as it is carried along through the atmosphere, develops upon its surface a charge of static electricity through friction with the air. This static electricity should not be confused with current electricity such as is developed by a dynamo or battery. As the name implies it is "electricity at rest." Although at rest normally it has enormous potential possibilities and the charge on the cloud is at all times seeking to reach the earth which is of the opposite polarity, or else to jump to a neighboring cloud of lower potential or opposite polarity. The air between the cloud and the earth is a non-conducting medium or dielectric which prevents this discharge until such time as the pent-up pressure becomes so enormous (millions upon millions of volts) that the layer of air is punctured. and then we see the lightning flash, that which is visible to the eye being particles in the atmosphere heated to incandescence by the passage of the discharge.

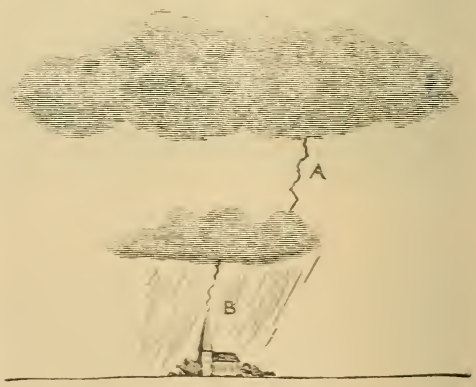


ORDINARY "A" DISCHARGE

Sir Oliver Lodge, the noted English scientist, has pointed out that lightning discharges are of two distinct characters which he has named the A and B flashes respectively.

The A flash is of the simpler type which occurs when a charged cloud approaches the earth without another cloud intervening. In this case the discharge is not as powerful as in the case of the B type where another cloud intervenes between the cloud carrying the primary charge and the earth. In the first case an ordinary lightning rod may be effective either by absorbing the energy of the stroke or by conducting it to ground in the form of a "silent discharge." In the B type, however, the two clouds practically form a condenser, and when a discharge from the upper cloud takes place to the lower cloud the potential between the lower cloud and the earth reaches appalling proportions and the resulting lightning stroke to the earth is a veritable electrical avalanche. In its erratic course it overwhelms everything and no lightning rod or conductor was ever made which can for a moment carry away safely this electrical deluge.

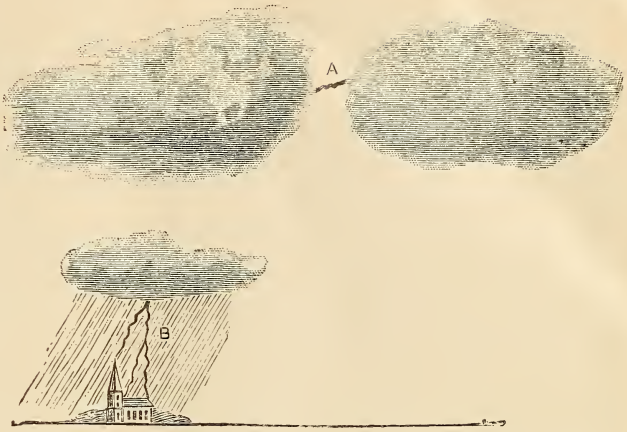
In an English work entitled "Modern Lightning Conductors" this difference between the A and the B discharges is graphically illustrated. In the first figure we have the ordinary A discharge which seeks the highest point on the earth's surface in order to relieve the pressure. As mentioned before in such an instance a lightning rod properly installed may be effective. In the second instance there is an ordinary A discharge from the upper cloud to the



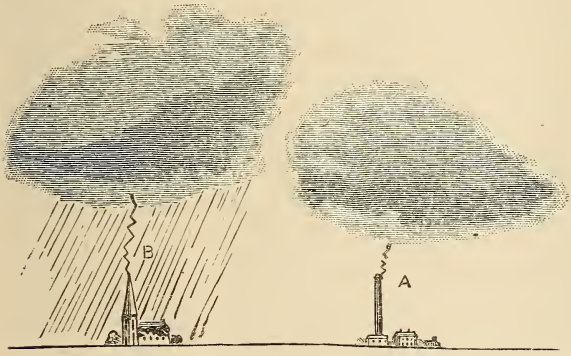
ORDINARY "B" DISCHARGE

lower one, resulting in a B discharge to earth. The third and fourth illustrations show modifications of this class, the discharge at A precipitating a discharge at B, the place where B occurs having been subjected to no preliminary strain.

With the A flash the difference of pressure is gradually established between the cloud and earth, and in this case pointed conductors are efficient lightning protectors. The glow discharge in such cases which is noticeable on the upper parts of the building and from the air terminals of the lightning rods seems to prepare the path for the real discharge and neutralize its force to a great extent when it does come. The heated air from the chimney acts in a some-



"B" DISCHARGE INDUCED BY "A" DISCHARGE BETWEEN UPPER CLOUDS



"B" DISCHARGE INDUCED BY NEIGHBORING "A" DISCHARGE

what similar manner and will conduct the discharge to the stove or source of heat in a dangerous manner, if it is not in connection with the earth. The lightning rod, if properly installed will prevent this deviation.

Motors to Drive Ship Propellers

The Institute of Marine Engineers in London recently discussed the subject of electric propulsion of ships, and H. A. Mavor of Glasgow said that the prospect is very hopeful. Leading ship-builders have been considering it for some time. W. P. Durtnall said that in the all-electric Paragon method of driving vessels, the electric motors are coupled direct to the propellers, and run at equally high efficiency in either direction. Since the ordinary steam turbine can run in only one direction, the new method saves the expense of a reversible turbine.

Kaiser Studies Electrical Farming

Emperor William of Germany is said to be backing a series of experiments being made to stimulate plant growth by means of electrical currents. An electric plant producing electricity at 250,000 volts has been installed and a large tract of ground is strung with an intricate network of wires over which the electricity is distributed.

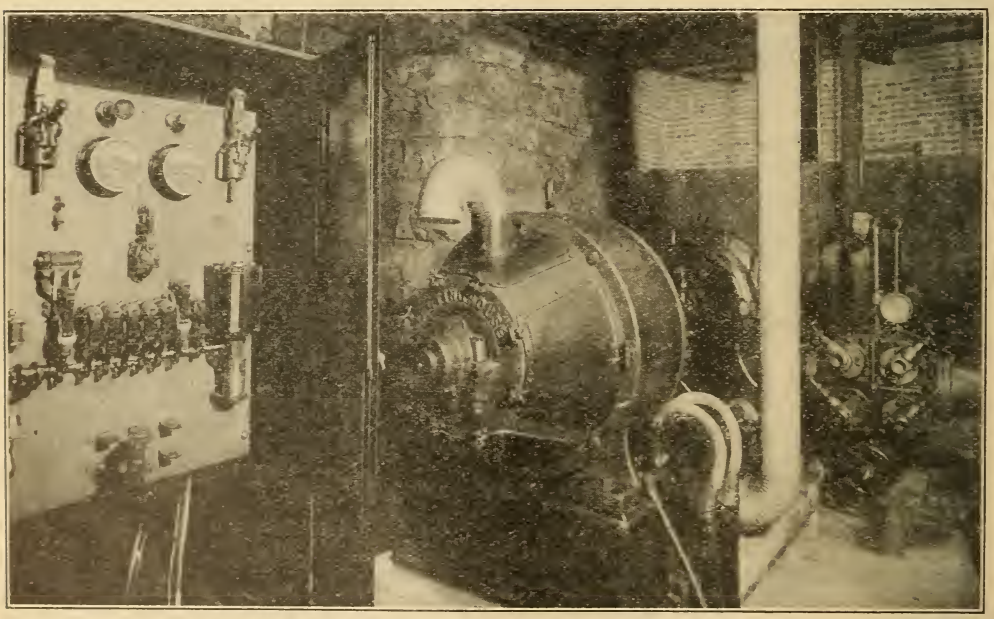
Dr. Hoechstermann, who is conducting the experiments, declares that cereals, flowers and all kinds of vegetation have grown more rapidly under this sort of electric stimulation.

It is the statement of Dr. Hoechstermann that not only will vegetation grow more rapidly under electric stimulation, but also that more abundant crops can be grown. He also says that all fertilizers can be done away with. It is his prediction that, within a few years, "electrical farming" will be the rule among the agricultural classes. The experiments at Dahlem station are being done in a private manner. Emperor William is greatly interested in the scheme and permitted the experiments to be conducted on one of the estates belonging to the imperial family.

Approved Electrical Fire Fighting Equipment

A complete fire-fighting outfit, consisting of an electrically driven centrifugal fire pump, motor, starting apparatus and compression tank is shown in the accompanying picture. This outfit has been accepted by the Underwriters, when properly installed in connection with sprinkler systems in Chicago. These sprinkler systems consist of a great number of water pipes arranged under the ceilings of the rooms, each having numerous "heads" which open when the temperature reaches a given degree, literally drenching the room with water, putting out the fire which caused the rise in temperature.

filled with water, above which is air. This tank is connected with the fire pump and the sprinkler system as a sort of cushion to prevent a too frequent starting and stopping of the motor. From the top of this tank, a half inch pipe runs to a diaphragm or pneumatic governor. When the pressure in this tank and consequently in the system falls below a given point, as would be the case if a head were opened, the pressure on the diaphragm decreases, and the movement of the diaphragm automatically closes a switch which allows current from the regular power circuit to pass around through a coil of iron on the solenoid, which is the largest device on the board, shown on the right. A plunger in this solenoid then rises slowly, due to the



APPROVED ELECTRICAL FIRE EQUIPMENT

The most interesting part of the equipment is the starter shown in a metal cabinet at the left. It starts the motor (shown in the foreground), the pump being on the same shaft, whenever the pressure in the sprinkler system falls below a certain point, and stops the same whenever a predetermined high pressure is reached. This maintains a practically steady pressure on the system whenever a leak occurs or a sprinkler head or heads are fused.

At the extreme rear in the illustration is a 2,000 gallon steel compression tank partly

action of the electric current flowing in the coil, and in doing so turns the horizontal shaft to which it is geared by a rack and pinion. On this shaft are crank operated carbon contacts. You can see a half a dozen of them in a row, which are thrown in one at a time. These cut out in regular sequence what are known as "starting resistances" in the motor circuit, causing the latter to start up and operate the pump. As soon as the water pressure is restored to the desired point, the diaphragm governor opens the circuit through the solenoid and the motor

stops. The motor can also be started by hand if desired.

No fuses are used in either of the motor leads, circuit breakers being employed instead, the idea being that circuit breakers can be almost instantly thrown in should they open the circuit, while to replace a fuse requires too much time in case of fire. Each circuit breaker is set to open only upon 150 percent in excess of the current which the motor would ordinarily require, to avoid opening except in case of extreme trouble or a short circuit.

The motor is so well enclosed as to be termed "splash proof." Between the motor and pump is an enclosed cooling fan to keep the motor cool. This draws the air into the short pipe, down upon the commutator of the motor, through the machine, and discharges it through the longer pipe, running up to the ceiling, and delivers it to a point outside the motor room. The motor is of 100 horse-power capacity, and the two stage centrifugal pump is capable of delivering 1,000 gallons per minute against a net pressure of 100 pounds at the pump, or equivalent to four good 1⅛ inch fire streams.

Finally to make sure that current to the motor can not be cut off by opening the switch or a circuit breaker, or by failure of the city lighting company on account of accident, without this fact being instantly known, the leads from the board to the motor are connected with an ingenious electrical device which automatically closes a transmitter circuit, sending in a fire alarm signal.

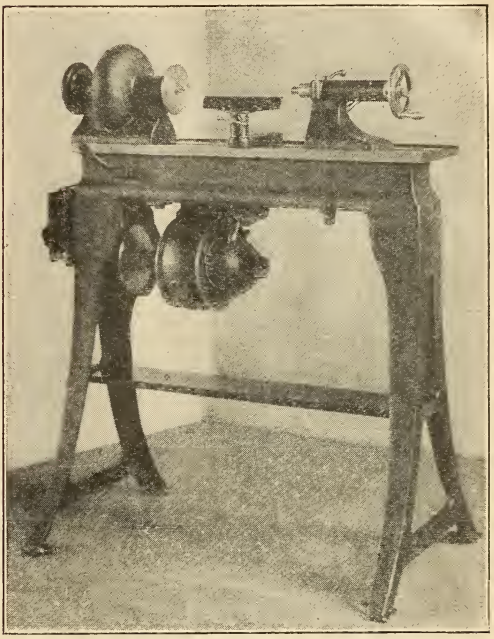
Musical Advertising

A Paris correspondent of Popular Electricity draws attention to the fact that musical advertising, by means of the singing or whistling arc lamp, is being tried in that city. To the right and to the left of one of the store entrances there were hung rather low, two singing, whistling and talking arc lamps, and during their operation a considerable crowd would constantly be gathered in front of the entrance listening to the sounds. [The mechanism of such a singing arc lamp was described in the June issue.]

Instead of offering the crowd something to see it was enchanted by the sweet tones of a familiar tune intermingled with some advertising talks in order to render the advertising most interesting.

Electric Lathe Designed by Students

Students at the shops of the Worcester Polytechnic Institute have designed and built a type of electric driven, high speed lathe which operates somewhat on the principle of the friction-driven drill. The object



NEW TYPE OF ELECTRIC LATHE

of this design is to obtain absolute control of the speed variation.

Operation of the machine is as follows: Underneath the bed is mounted an electric motor which carries on the end of its shaft a vertical steel disk which revolves at great speed. At the left of this disk, and barely visible in the picture is a vertical shaft carrying a little wheel with a face of some frictional material which will give it a good grip on the face of the steel disk. This friction wheel can be moved up and down against the face of the disk. When it presses near the center of the disk the speed is slow. When it presses near the outer circumference where the speed of the disk is greater this little friction wheel revolves at a much higher rate. The shaft of the friction wheel in turn drives the lathe. The handle shown on the left end of the machine is for raising and lowering the vertical driving shaft and gives any speed adjustment desired.

Readiness to Serve

"My light bill was $6.87 this month" says Jones to Smith. "Outrageous! Can't understand it," says Smith. "The lighting company is getting thousands of new customers every year. The plant is more economical than ever before. Why don't they think of us poor fellows and cut the rates a little more." We often hear remarks like these. But do we stop to think of the problem with which the central station must contend? If you who are reading this have figured it out suppose you propound a universal plan of charging for current that will do away with all "kicks," make every customer satisfied and give the central station a fair return on its investment. It would be an easy way to become famous; that is, if you could dream out the solution of the problem. But were you to begin to study the question and try to calculate what the rates should be you would find yourself in more than a peck of trouble.

Mr. S. E. Doane, chief engineer of the National Electric Lamp Association recently read a paper before the Canadian Electrical Association on the "Conservation of Our Natural Resources Through the Use of High Efficiency Lamps." In this paper he endeavored to show how the introduction of the new tungsten lamps, which give a much greater candle power for the same current than the old carbon filament lamps, will have the effect of saving a great deal of our rapidly decreasing fuel supply, but how it incidentally turns topsy turvy all the established methods of charging for current. For instance, the central stations want to save fuel. They want to give their customers more and better light. But they don't want to necessarily "saturate" them with light by giving them three times the light for the same money, and if they give them the same light for one-third the money fair profit will vanish—and you couldn't expect that of a corporation any more than of an individual.

What is to be done in a case like this? What remedy can be suggested to eradicate the shortcomings of the system of charging for current by the number of kilowatt-hours used? This system has its disadvantages and inconsistencies realized by the central stations as well as their customers, but to date it seems to have been the only way out.

Mr. Doane dwells upon this point in his paper and brings out that factor in establishing rates which few of us realize; that is, the ability of "readiness-to-serve" on the part of the central station. The following is quoted from his remarks and will open the eyes of users of current to the fact that the path is not all roses to the central station manager who is endeavoring to establish a rate at once fair to the company and to its patrons.

"A rather striking analogy may be drawn to show the present situation [referring to the introduction of tungsten lamps]. Suppose that a small city of 10,000 inhabitants has organized a fire department, investing considerable money in a building and equipment. A force of men is maintained constantly at the station, in order to answer any alarm sent in. We will suppose that, for several years, this department had on an average one call a week, and that for some reason (as illogical as that upon which the present system of rates was based) it was decided to pay the department on a call basis, that is, so much for each call attended. The records are carefully gone over, and it is found that the yearly expense, including fixed and operating charges is $26,000.00, and that 52 calls (or an average of one call a week) were responded to during the period considered. This makes a total cost of $500.00 per call, and so, upon the basis of these figures and conditions, it is provided that the department shall receive $500.00 for each fire attended, which amount just covers all expenses.

"Here we have adjusted the rate for service on a basis which very apparently is illogical but which under the conditions permits an income sufficient to meet the cost of service. After having this all nicely adjusted assume that, due to the installation of a lot of fire-extinguishers and sprinkler system, the number of fires is suddenly reduced to one-third of the previous number so that the station responds to an average of only one call in three weeks. With the income reduced to one-third of its former value the station rapidly becomes heavily involved in debt.

"The original figures, taken from the period of operation before the number of fires was reduced shows, upon closer analysis, that

the total yearly expense of $26,000 was made up of fixed expense of $23,400 and a variable expense of $2,600. Dividing $2,600, the variable expense, by the number of calls responded to shows that the actual cost per call is only $50 in excess of the fixed charges. The logical basis of appropriation would have been to have allowed $23,400 per year to cover the expense which is fixed regardless of the number of calls attended, and, in addition, to have allowed $50 for each fire attended, which would have covered the actual expense created by the call.

"The department would then have been on a readiness-to-serve basis, and a fixed income to cover the fixed expense would have been assured. With a reduced number of fires the saving to the community would have been the saving due to a fewer number of runs at $50 each.

"The $23,400 per year is the readiness-to-serve charge, and represents a value received in assurance of prompt service on demand. The $50.00 per fire simply covers the expense which an actual run entails. It would be folly for the community to expect a reduction in the readiness-to-serve rate under such conditions, since fire protection represents a certain definite value and requires a definite fixed charge to cover the interest on investment, and the fixed operating expense of the department. A reduction in the number of fires only makes the possibility of loss more remote but does not decrease the value of the protection.

"Such, to a great extent, is the state of affairs in the central station field today. The system of charging for service by the number of kilowatt-hours consumed does not represent and cannot represent the true cost of service. It is manifestly a poor arrangement by which the consumer is charged for service on a basis which does not represent the cost of such service, and it needed but the advent of a high efficiency lamp to make the incongruities most apparent. When we remember that from fifty to ninety percent of the central station's yearly expense is fixed regardless of the output, and that the income which is to cover such fixed expense and presumably leave a margin of profit in the majority of cases varies directly with the output, we see at once that with high efficiency lamps there is a great possibility that the revenue may be reduced to such a point that the margin of profit is entirely wiped out, and the plant operated at an actual deficit.

"Central station expense can be classified broadly under two heads, Investment and Operating.

"The Investment expense covers the principal items of—

"Interest on notes and outstanding bonds.

"Dividends on Capital Stock.

"Reserve and Depreciation Fund.

"The Operating expense includes all—

"Fuel.

"Wages.

"Repairs.

"Supplies.

"General Expense.

"A careful analysis of the investment expense shows that part of it is proportional to capacity and part of it to the number of consumers connected. Each item of investment should be considered individually and placed as a definite charge to capacity or to number of consumers connected. The same analysis can be applied to the operating expense with the addition of a charge to output. A considerable part of the operating expense is proportional either to the size or capacity of the system or to the number of consumers connected. Only part is strictly proportional to the actual output of the station.

"To be more specific, practically all fuel, oil, water and boiler room labor is proportional to output, although a part of each can properly be charged to capacity. The expense of keeping fires banked in readiness to serve a quick rise in demand is a capacity charge. As to boiler room labor, as a rule the smaller the station the larger is the proportion of this expense which is chargeable to capacity. General office and executive expense is largely dependent upon the capacity of the plant. Meter reading, billing and other work in connection with customers' accounts, and much of the labor and repair of the distributing system is proportional principally to the number of consumers connected.

"Having analyzed the cost of service and distributed every item under the head of Capacity, Consumer, or Output charge, it is very desirable to evolve a system of rates which will cover the expense as above determined. This is the remedy for the present situation—a remedy which would put the entire matter of rates on a proper foundation, and would enable the central station to keep up its income, and conserve fuel at the same time.

"The Doherty Readiness-to-Serve rate is based upon this sound reasoning, and covers the three items of expense by three corresponding charges to the consumer. This system can be illustrated by the following schedule:

15c per month for every 16 c. p. lamp or equivalent c. p. connected, as capacity charge.

75c per month regardless of current consumption or connected load, as consumer charge.

5c per kilowatt-hour used additional to above fixed charges, as output charge.

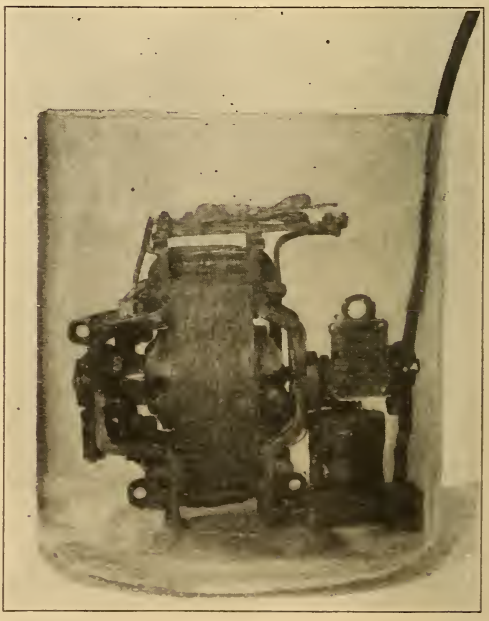
"A discount of 10 percent is usually allowed on the bill if payment is made before a specified time. The capacity charge of 15c per 16 c. p. lamp connected is, as will be noted, based upon the candlepower and not the wattage connected; this arrangement can be justified on the following basis: Suppose a central station has a certain number of customers all using low efficiency carbon lamps; if all these customers should at one time replace their carbon lamps with the equivalent c. p. in tungsten the current consumption and connected load would both drop to one-third of their former value. Now the customers have to bear the fixed expense of the station; and as neither the fixed expense nor the number of customers is changed by the substitution of the high efficiency lamps the fixed charge must be the same, that is, the only saving to the consumers will be the saving in current consumption made possible by using the high efficiency lamps.

"The central station will, however, have at its disposal two-thirds of its capacity, released by the use of the more efficient means of producing light. This represents a potential saving which will benefit both the central station and the consumer. The central station is in a position to increase the number of customers served very greatly without any increase in generating equipment so that, while the increase in customers may represent a small increase in distributing investment, the total fixed charges are not increased nearly as rapidly as the number of consumers. This makes the burden of fixed expense per consumer less and less, as the apparatus released by the use of high efficiency lamps can be utilized in supplying additional consumers. It is only as this apparatus is put into economic use that the fullest benefit of the lamp will make itself felt to both the central station and the consumer, in the gradual reduction of fixed charges and the possibility of producing the light at the best economy. The saving immediately felt is one in the output or current consumption and it is gratifying to know that with every installation of high efficiency lamps on central station circuits, progress is being made towards the more economic use of the natural resources which it is our duty to conserve."

Motor Runs Two Weeks Under Water

The accompanying illustration shows an electric motor undergoing one of the most severe tests to which it could be subjected and through which it passed successfully without a breakdown.

A company which manufactures a well known cash register wished to demonstrate



MOTOR RUNNING UNDER WATER

the high efficiency of the insulation used on the motors built to operate some types of the cash registers in place of the ordinary crank handle. So one of the motors was placed in a glass jar of water and the current turned on.

The motor was in continuous operation under water for over two weeks. At the

end of that time the commutator bars (the copper segments which collect the current from the brushes and pass it on to the armature wires) were badly eaten away by the electrolytic or battery action of the current flowing through the water from one commutator bar to the next. But the machine was still able to be operated and the insulation was found to be perfectly sound.

A second motor was then submerged. This was run for one week and the current then turned off and the motor left under water for about two months. After this the current was again turned on and to everyone's surprise the motor started right off as if nothing out of the ordinary had transpired, despite its long bath.

The entire armature and field coils of these motors are impregnated with insulating compound by a vacuum process. After being so impregnated the field coils will withstand an insulation test of 50,000 volts before they will break down.

Water Heaters for Dentists

Did you ever sit in a dentist's chair and after the tearing and rasping of the drill had ceased experience the appalling sensation of having water, either too hot or too cold,

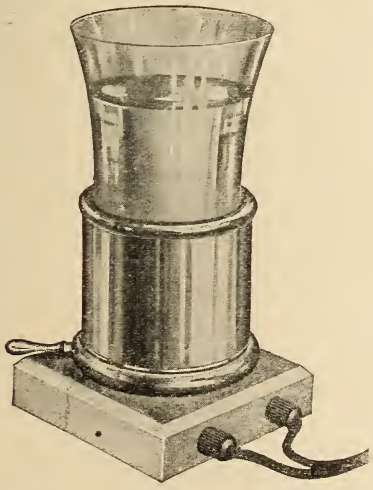


FIG. 1. DENTISTS' WATER HEATER

squirted into the cavity? If you ever did you will hope for the day when every dentist will be provided with an electric water heater which will supply water at exactly the right temperature for this delicate operation, and leave nothing to guess work. Such water heaters are now made and are becoming widely used.

The heater shown in Fig. 1 consists of a nickel plated cup mounted on a polished marble base 3½ inches square. This metal

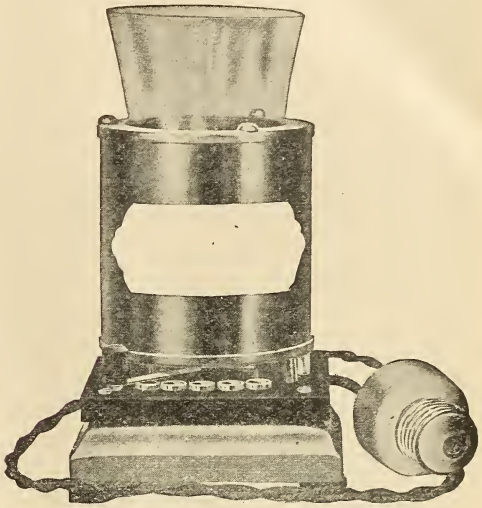


FIG. 2. DENTISTS' WATER HEATER

cup embodies an electric heating device supplied with current from the lamp socket; either alternating or direct current may be used. A tumbler conforming to the shape of the metal cup is supplied.

At the bottom of the heater is seen a small handle by turning which five different heats may be obtained giving approximately 90, 100, 110, 138 and 165 degrees Fahrenheit. To keep the water at the right temperature for syringing cavities use the first or second heat and leave the current on continuously. So little current is used that it would not cost over one cent for 10 hours. The fourth heat is very convenient for softening inlay wax.

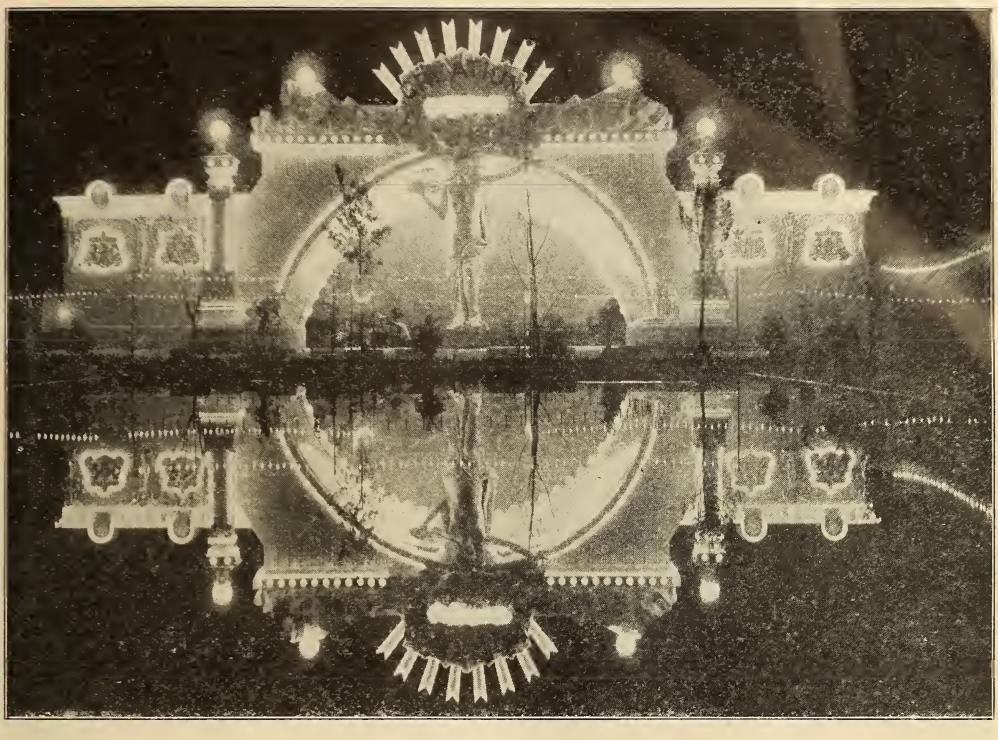
An important feature of the device lies in the fact that it is always ready right at the dentist's hand, saving many steps in the case of a long operation.

Fig. 2 shows a slightly different type. This has four distinct heats obtainable by moving the lever at the bottom over the contact buttons of which there are five, current being off on the first button. The glass holds 140 cubic centimeters of liquid which heats very rapidly on the fourth button. The lever may then be dropped back to the second button, which will hold the temperature at approximately 104 degrees Fahrenheit.

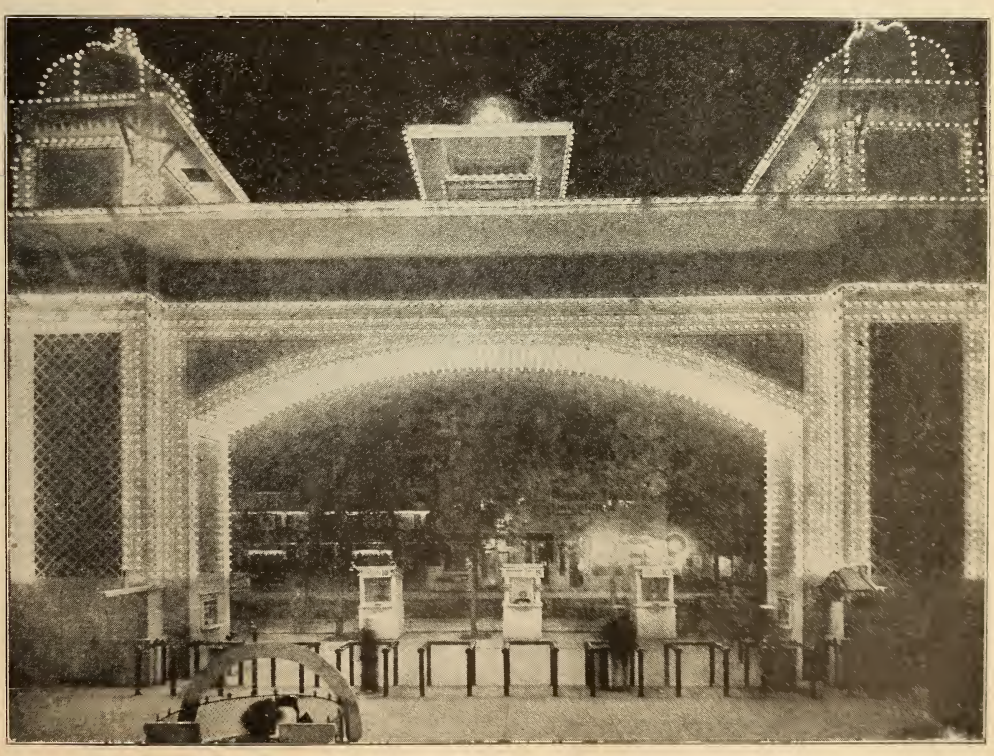
The Playgrounds of a Big City

What shall we do tonight? Too hot to go to the theater. Let's go to White City, Riverview, Forest Park, San Souci. This is the question that is asked and answered by thousands upon thousands in the city of Chicago. The same question is asked and answered in the same way in almost every city of any considerable size in the country, for today the amusement park is the recognized playground of a city. People must play as well as work in this world, and these little cities of light, life and activity, to which the name "amusement park" has been given, present a natural outlet for the pent up spirits of those who play as strenuously as they work.

WHITE CITY AND ITS ELECTRIC TOWER



CREATION—A MARVEL OF LIGHTS AND REFLECTIONS



ENTRANCE TO RIVERVIEW EXPOSITION

THE GATES OF FOREST PARK

And did you ever stop to think that these pleasure resorts owe their existence solely to electricity and its myriad applications? In the first place there must be light—light almost like the day itself—for both illumination and decoration. Electricity alone gives the desired effect. Then, too, the various amusement "features" depend upon electricity for power to operate them and for the illusion effects which can only be obtained by use of the magic current. Scenic railways, giant swings, human roulette wheels, chutes, steeplechases, creations and doomsdays—all respond to the turn of a switch.

LEADING THE FIELD

In Chicago the four great amusement parks represent four distinct types. White City represents the concentration of light and activity. Situated within the confines of two or three city blocks and lighted with tens of thousands of electric lamps and with the lofty electric tower, second only, in beauty, to the famous Pan American tower, it is truly the gem of the great South Side.

Riverview Exposition with its 106 acres of grounds is laid out after an entirely different plan. Here are cool groves with lighted walks, little streets of intense illumination, and in the midst of all "Creation," a central figure of entrancing beauty with its every detail faithfully reflected in the pool of the Grand Basin.

Forest Park in the West Side suburbs is built up around the steeplechase as the central attraction, where thousands flock to enjoy a ride on "the ponies."

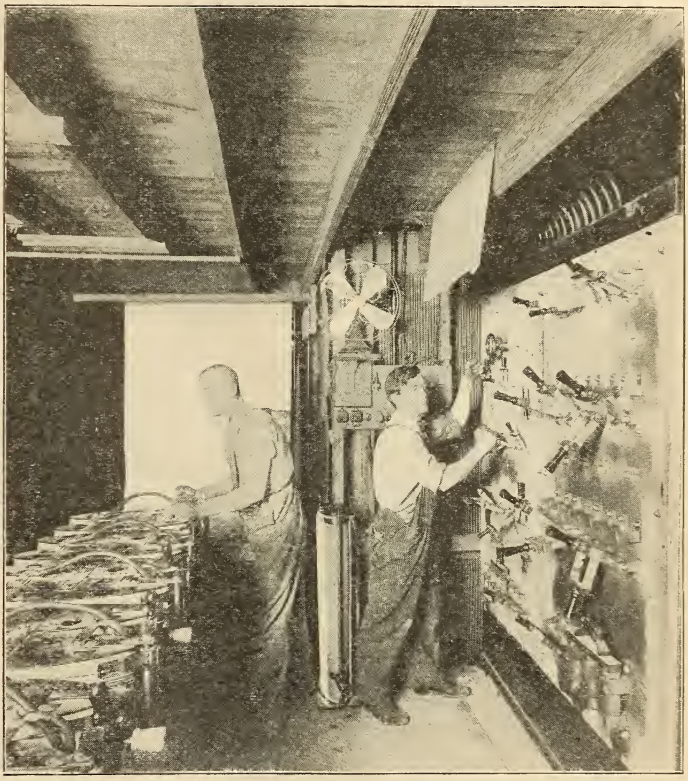
San Souci is the "family park" of the city. Though not possessing the grandeur and display of the other parks it has a picturesque beauty as distinctive in its own way.

As an example of how electric current is utilized in some of the features of entertainment, "Creation" at Riverview may be cited. The entrance to this remarkable product of human ingenuity is shown in one of the illustrations, the figure in the foreground being over fifty feet high. In the decoration of this entrance 4,680 incandescent

lamps are used. Within is a great amphitheater with a stage nearly twice the length of that of an ordinary theater. In the rear of the stage and facing the audience is a vaulted background against which the wonderful effects are produced.

The successive scenes in the drama, silent save for the occasional uproar of the elements, represent the creation of the world—the first six days and finally the day of rest. First is utter darkness: unbounded space. From out the turmoil of the elements and the formless nebula gradually appear the waters—a heaving sea covering all. Then out of the waters rises the first mountain peak followed by others until the scene represents a land of mountains, valleys and plains. Presently plant life appears on the hills and in the valleys, followed by animal life and then by the first man and woman. On the seventh day the turmoil of the elements has ceased and peace and quiet are over all.

The performance lasts for over half an hour and during all this time in the switch-board and spot-light galleries above the stage, and in the room beneath, men have been performing in predetermined sequence the various manipulations necessary to the production of the spectacle.



CONTROLLING THE LIGHTING EFFECTS IN CREATION

The appearance and disappearance of the various elements which go to make up each scene, such as clouds, mountains, hills, etc., are brought about by raising and lowering from beneath the stage successive rows of painted scenes which extend higher and higher in successive tiers toward the back of the stage. Upon these scenes are thrown all the electric light effects known to the modern stage art.

One of the illustrations shows the electric switchboard gallery from which the electrical effects are controlled. There are eight sets of border lights each containing 125 lamps which are thrown on and off in any combination from the switchboard. In the front is a row of eight "dimmers" by which the intensity of the light from these border lamps can be controlled so as to bring the light up from a faint glow to full brilliancy, producing any effect from faintest dawn to broad daylight. The wave motion of the sea is produced by a device worked by electric motors, also controlled from this switchboard, as are the lamps which make the stars twinkle in the background.

Extending across in front of the stage but above it and out of sight of the audience is a long gallery where are located the thunder machines, the "volcano" cannon, rain machines and also eight electric arc spot lights, among them special lamps for making the sun and moon and for producing snow and rainstorm effects, and the zig-zag lightning flashes across the vaulted background of the stage.

To make the sun rise, for instance, one of these lamps is provided with a special shutter with a round hole for throwing the

"sun" spot on the background. This shutter is operated by clock-work. The light is thrown on at the horizon and the clock started going, which moves the slide slowly so that the sun travels at a uniform rate up across the sky. The moon is operated in the same manner, also the rain and snow lamps, which project rapidly falling points of light.

Lightning flashes are projected from other lamps having special shutters or screens in which zig-zag openings are cut. These are momentarily exposed in front of the projector.

"Creation" is of course but a single example of the numberless concessions which depend entirely upon electric current for their operation. Without it there would be no amusement parks and it would be more difficult to find an answer to that little question: "What shall we do tonight?"

Traveling Electric Sign in Paris

Perhaps the most original electric sign in Paris, France, is that of a representative of an English firm. It is located on the facade of the building and the letters travel around on a track like miniature railway

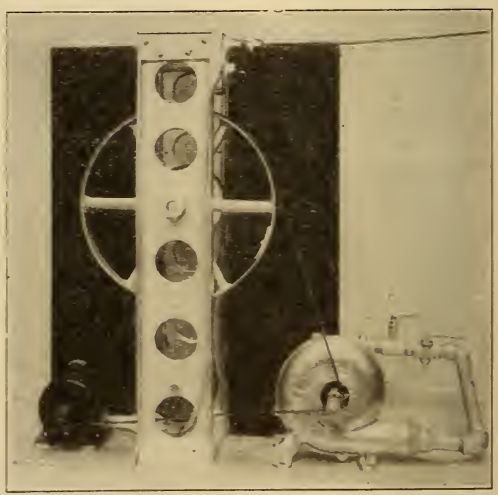
TRAVELING ELECTRIC SIGN

cars. Just below the fourth floor are fastened the electric rails following the curves of the entire facade. On these rails are hung the wooden letters forming the sign. Each letter has two or more wheels, according to the size of the letter, so that all the letters can roll along on the rails. In order to insure a regular movement of the whole the different letters are tied together by means of steel wire.

Every third letter is provided with a small electric motor, and when the current is switched on in the office the whole mass of letters forming the sign is made to move clear around the whole front like a miniature electric train. In the evening the letters are illuminated by incandescent lamps. The effect of such an electric moving sign is quite extraordinary and presents a novel spectacle.

Electric Driven Corn Popper

Popcorn, as every one knows, is consumed literally by the wagon loads at large amusement resorts. It is a problem for those who have concessions in the most favorable locations to turn out the product fast enough to supply the corn hungry public, by old hand operated poppers—hence the electric power popper. A power driven equipment of this nature is shown in the cut. The small electric motor down in the left hand corner of the picture, which is a view of the back of the machine, drives the chain



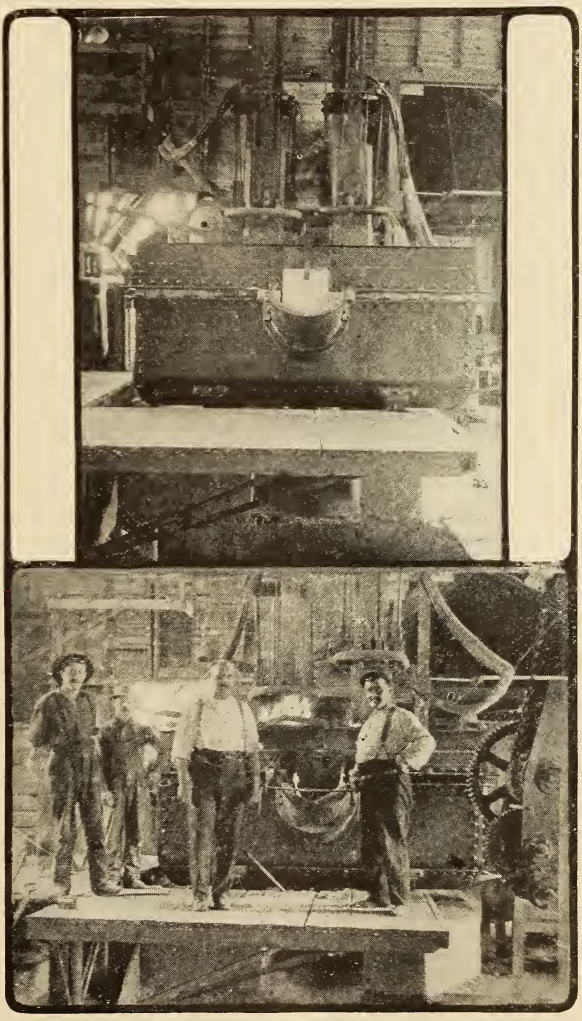
ELECTRIC DRIVEN CORN POPPER

gear which rotates the corn popper and also drives a small blower attachment. This blower is used to increase the gas pressure to the burner and consequently the heat, and enables three or four times the amount of corn to be turned out for the same fuel cost.

Making Steel by Niagara Power

Ingots of solid steel, weighing 500 pounds each, are produced by a giant electric furnace in a plant located near Niagara Falls. Electric current for this process is obtained from one of the hydroelectric plants at the Falls where the price of electric power, due to the exceptional natural facilities for its production, is so low as to make it available for the making of steel.

The electric furnace is of the Heroult design and consumes 1,000 horsepower while in operation. It is capable of making five tons of steel in a single heat. The Lash process, which is used, consists of making a mixture of concentrated magnetic ores or iron ore sands, granulated pig iron and carbon for charging the electric furnace. It is held that it is not strictly a direct process but is an ore and pig process, the ore being greatly in excess of the pig iron employed. It is maintained that the amount of pig iron required to make a ton of steel in this manner is only about half of that required in the open hearth furnace, as the electric furnace operates with a non-oxidizing atmosphere. The ore, cast iron borings or granulated pig iron and charcoal or coke are thoroughly mixed with a small proportion of lime, the latter being used to keep the material embalmed, and consisting of only about four per cent. The mixture mostly used includes about 10 per cent of coke dust and 23 per cent of granulated pig iron or cast iron borings, and about 63 per cent being magnetic iron ore.



ELECTRIC FURNACE AT NIAGARA PLANT

The batches of this mixture are 500 pounds in weight, and the mixing requires about 15 minutes. The electric furnace is charged with enough of these mixed batches to make approximately four tons of steel, and then steel scrap is scattered over the top, 100 pounds being used with a small bar of iron to form an arc between the electrodes when they are lowered into position and the current turned on. The current then continues to flow from one electrode to the other through the mass and develops intense heat. The entire batch of material being melted thoroughly the slag is poured off and a final refining material added for producing the quality of steel desired.

It is held that the physical properties of the steel are superior to steel made with the usual scrap and pig processes.

Current Economy for Moving Picture Arcs

By F. G. WALDENFELS

Motion pictures are a form of public entertainment that has developed with great rapidity into an industry of enormous proportions, employing thousands of men and women and with millions of dollars invested in property. As in any other undertaking, the success or failure of a moving picture theater depends as much upon the economy of its operation as upon the volume of its business, and the ability of the manager to stop the little "leaks" may spell the difference between success and failure.

Moving picture theaters are great users of electric current, and indeed without electricity they could scarcely exist. The intensely illuminated snow-white fronts first attract the passer-by and invite him to enjoy the sights within, and the amusing and instructive entertainments which it is his privilege to enjoy for the small sum of a nickel or a dime are made possible only by the modern electric projectoscope.

In the operation of the moving picture arc lamp lies one of the opportunities to economize. These arcs may be operated with a great waste of current, or devices may be employed which will cut down this expense to a minimum, and not only does the theater management appreciate the significance of such innovations but the central station company furnishing the current, as well, for it is the satisfied and prosperous customer which in the long run is the paying customer for the central station.

It is the object of this article to discuss the different successful devices used for operating moving picture arcs on alternating current so that any operator or electrician can understand them.

There is always a certain important item to consider in electrical construction and that item is safety from fire, and everything will be presented in this article from an underwriter's point of view, and this is to eliminate the fire hazard and install all wiring according to the rules of the Underwriter's National Electrical Code. In the beginning a great many oil cooled rheostats were sold in the field, but were condemned by the Underwriters, and now most of the manufacturers of these devices are making the air cooled type which is approved.

In the use of alternating current it is a problem to supply low voltage to moving picture arc lamps, and the following methods are a few solutions which best fill the requirements at present:

1. Jacobi & Harris Reducer: a reactance coil in series with the arc lamp.

2. Don J. Bell Auto-transformer or Inductor Compensator: having three sets of connections in the primaries to give about 55 amperes at about 33 volts in the secondary leading to the arc carbons.

3. Ft. Wayne Compensarc: a simple transformer winding and core with lamp directly across the secondary winding. To adjust the current, two reactance coils are provided in series with the arc lamp.

4. Winchester Magnetic Rheostat: a transformer with the secondary current adjusted by means of a magnetic shunt.

5. General Electric Economy-Arc: a step-down core type transformer with a one primary and one secondary coil. The secondary coil is in series with an auxiliary winding so connected as to introduce a current in the secondary opposite in direction to that in the main winding.

6. General Electric Mercury Arc Rectifier: for converting alternating to direct current, with the assistance of a compensating resistance.

7. Motor-Generator: for converting alternating to direct current of suitable voltage for operating the arc.

These devices have all been tested by the Underwriters Laboratories, for economy, efficiency, variable voltages, high power factor, insulation and break down test, temperature rise, etc. The laboratory has endeavored to induce the manufacturers to dispense with the waste heat, noise and humming at the lamp, reduce the carbon consumption and increase the light 30 to 50 percent above the results from the same amperage obtained from a rheostat. Also to make the efficiency of the lamps great enough to overcome the greatest film densities, long distances, irregular strength and eventually breakdowns.

All these devices can be subjected to a severe breakdown insulation test with 1000 to 5000 volts alternating current and are abso-

lutely safe and indestructible. Lighting companies are favorable toward them because they are not troublesome and are square with the meter.

Moving picture arc lamps operate at approximately 35 to 55 volts and 20 to 80 amperes. They are generally connected to 110 volt circuits, but in many cases where 220-volt, Edison, three-wire distribution is used, central stations have insisted on connecting the arc lamps on the two outside lines (220 volts) on account of the unbalancing of the system that the lamps would cause when placed across the neutral and one side of the line (110 volts).

Past practice used to reduce the line voltage to that required by the lamp has been to employ rheostats or reactance coils. Both of these methods are very wasteful of energy and therefore enlarge the current bill. Furthermore, the rheostats, nicknamed "stoves" by inspectors, are objectionable on account of the large amount of heat generated which not only makes the lamp house very uncomfortable for the operator, but is also a great fire hazard, as the rheostats often become hot enough to set fire to anything combustible that comes in contact with them.

Reactance or choke coils, while not quite so wasteful of energy as the rheostat, are not desirable on account of introducing into the circuit what is known to electricians as "reactance" which results in a large current at a low power factor being taken from the system, thereby affecting the voltage of the lighting circuit.

Of the approved devices it remains for the theater manager to choose the one best suited to his needs, and following is a brief explanation of the different devices:

J. & H. REDUCER

The Jacobi & Harris Reducer, Fig. 1, is an air cooled device composed of choke coils and replaces the ohmic resistance type of rheostat generally used. The coil consists of two windings of about No. 4 B. & S. gauge, cotton-covered, copper wire connected in series on a core of laminated sheet iron punchings. This device is designed for 110 or 220 volts, 60 cycles, 30 amperes, and can stand the test on a machine rated as high as 67 amperes, 220 volts. The device is manufactured to order and wound according to the circuit to which it is to be connected. The size of wire used for the coil is much larger than the rating of the device would require.

BELL AUTO-TRANSFORMER

The Don J. Bell Auto-transformer, or Inductor-compensator is a device which is used on alternating current circuits ranging

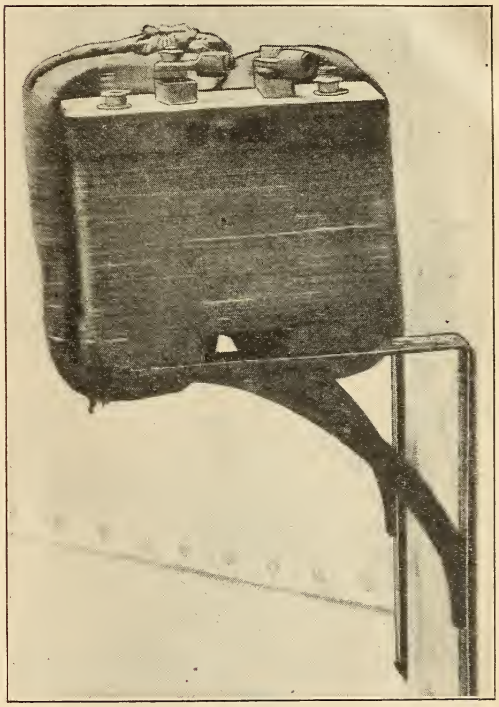


FIG. 1. J. & H. REDUCER

from 90 to 115 volts. It is provided with three sets of connections for the primary circuit and is designed to supply a current of 55 amperes in the secondary with a voltage of 33 at the lamp terminals. It has a power factor of .8864. The core is built up with sheet iron punchings in accordance with standard transformer practice and held together with brass bolts and nuts. The coils are form wound and dipped in an insulating compound and baked with two layers of tape over the outer surfaces of the coils.

The primary coil consists of a good many turns of about No. 6 B. & S. gauge, copper wire, cotton covered. Taps are brought out from a certain number of turns on the coil to separate terminal posts on the front. The secondary has a less number of turns of No. 6 B. & S. gauge, cotton-covered, copper wire, with taps brought out from different parts

of the winding to separate binding posts on the front. From a common point of these coils a wire is brought out to a terminal in the front for a conductor leading to one lamp terminal.

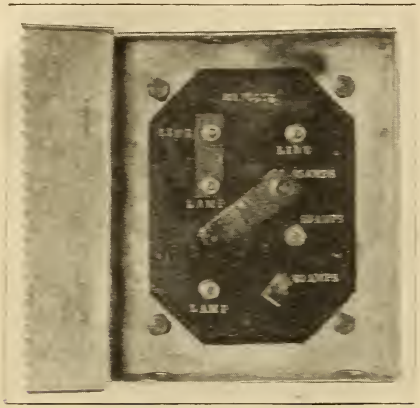


FIG. 2. TERMINAL BOARD OF BELL AUTO-TRANSFORMER

The front of the terminal board is provided with three sets of connections as shown in the diagram, Fig. 4, for line voltages ranging from 90 to 95, 100 to 104, and 110 to 115 respectively, which shows the device is adjustable to the extreme variation of the voltages.

FIG. 3. BELL AUTO-TRANSFORMER

Terminals (A1-a1), (A2-a2) and (A3-a3) are for 110-115, 100-104 and 90-95 volts respectively.

(L) is the common lamp terminal for all three variations. (C1), (C2) and (C3) are connected to the other terminal of the lamp according to the current that is desired.

A modified form of the auto-transformer recently put out is arranged so that current to the lamp can be easily varied. The design of wiring has been changed in the secondary, otherwise the compensator is about the same as the one previously explained.

On the slate base contained in the metal box at the top of the device, Fig. 2, are mounted three contacts marked respectively 45, 53 and 60 amperes, and a substantial spring brass switch arm is pivoted so as to be capable of being set on any one of these buttons. The purpose of this change is to permit ready variation in the amount of current to be delivered to the lamp from the secondary circuit. The lowest amperage on the board, 45 amperes, is sufficient for stereopticon projection, while the moving

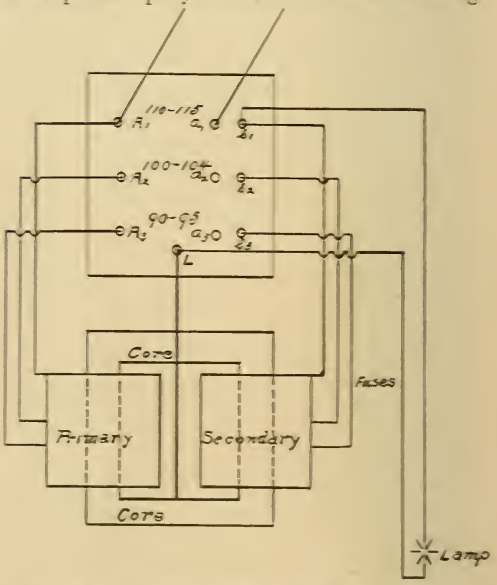


FIG. 4. CONNECTIONS OF BELL AUTO-TRANSFORMER

picture film very often requires the highest amperage obtainable. The complete device is shown in Fig. 3.

COMPENSARC

The Ft. Wayne Electric Works manufactures a Compensarc, or auto-transformer, Fig. 5, designed to furnish 14, 40 or 60 amperes to the lamps of moving picture machine outfits for 110 or 220 volts a. c. It is used intead of the common iron or other ohmic resistance type of rheostat.

It consists of a simple transformer winding and core with the moving picture arc lamp

directly on the secondary of the transformer winding. Two reactance coils are provided in addition which may be put in series with the carbons of the lamp.

The transformer is of the air-cooled type, and as shown in the diagram, Fig. 6, and has two additional windings, one in each side of the line. The core is built up of sheet iron punchings mounted on a flange.

A single pole, 500 volt, main-line switch with three contact jaws, controls the current in an odd way. When the switch is open the lamp circuit is open. When the switch blade makes contact with the first pair of jaws as shown in Fig. 5, the lamp circuit is closed with the two reactance coils in series with the carbons. When the knife blade is in contact with second pair of jaws the light

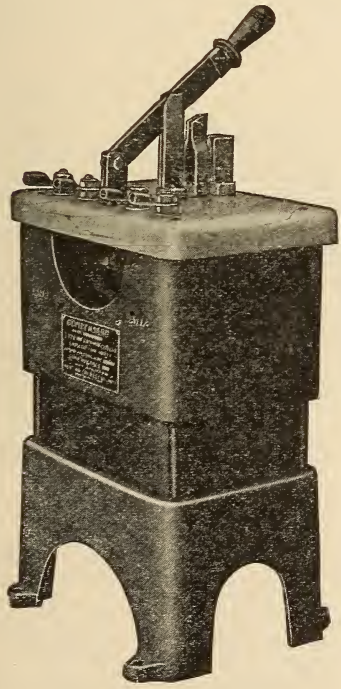


FIG. 5. COMPENSARC

reactance coil is short circuited. In the third position the knife blade is in contact with the first and third pair of jaws only, the second pair of jaws being so designed that they are not in contact with the switch blade when it is completely closed. In this position both reactance coils are short circuited and the lamp is directly across the line with the two transformer windings in each side.

These devices are furnished for any frequency desired, 110 or 220 volts a. c., and are designed to furnish currents in the lamp circuit with a voltage of 55 at the lamp carbons as follows:

Position 1. Both reactance coils in series with lamp, 14 amperes. This current will

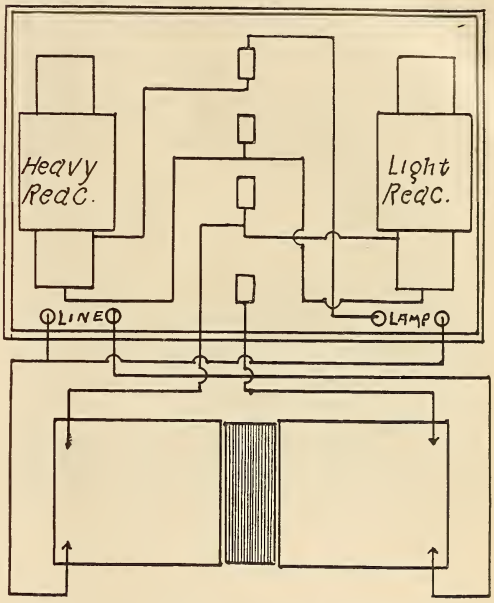


FIG. 6. CONNECTIONS OF COMPENSARC

warm up the lamp carbons and permit the operator to throw a bright light immediately.

Position 2. Light reactance coil short circuited, 40 amperes. Normal running current.

Position 3. Both reactance coils cut out; maximum running current 60 amperes. This current is often used when film is thick or smoked. The maximum loss on position 3 is about 200 watts.

WINCHESTER TRANSFORMER

A transformer with adjustable reactance coils in the secondary circuit is made by the Winchester Electrical Works, and is a simple transformer as shown in Fig. 7. A reactance coil having the winding adjustable in relation to the core is placed in the secondary circuit in the series with the lamp. It is air cooled and designed for a primary voltage of 110 or 220 volts a. c. as desired, and for a secondary voltage of 55.

About No. 4 copper wire is used for the reactance coils and these are wound in the same manner as the secondary coil. These

coils are mounted on a heavy wooden strip which is secured at the ends by slide bolts. These bolts engage holes in the sides of the case and the coils are thus supported. A series of these holes is provided, permitting

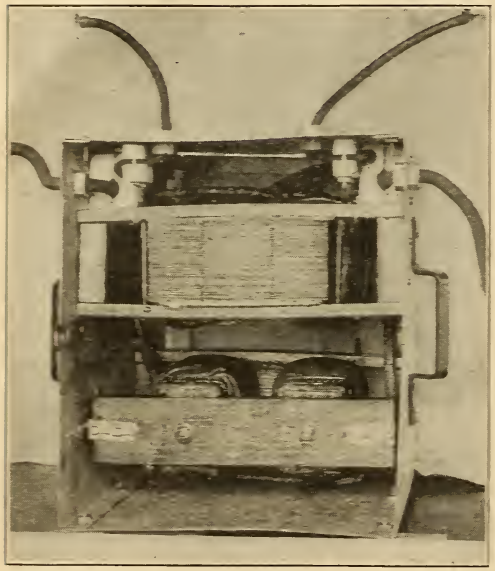


FIG. 7. WINCHESTER TRANSFORMER

adjustment of the coils so as to vary the number of turns about the wire. This adjustment provides a means of regulating the reactance in the secondary and provides for a corresponding range in the current flow.

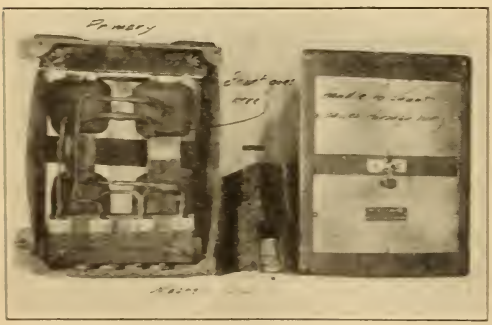


FIG. 8. IMPROVED WINCHESTER TRANSFORMER

An improvement on the preceding device, by regulating the secondary current with a magnetic shunt as shown in Fig. 8, is supplied by the Winchester Company. It is air-cooled and designed for 115 volts a. c. on the primary with the secondary current ranging from 40 to 55 amperes at 57 volts.

Two coils each are provided for the primary and secondary of the transformer. The primary and secondary connections are made on a board.

Fastened to a rod which runs through the center of the cover is the magnetic shunt, and by raising and lowering the shunt between the cores, a means of adjustment of the secondary current is provided. The shunt rod passes through the cover of the device and is readily accessible to the operator.

ECONOMY-ARC

Fig. 9 shows the General Electric low-potential transformer or Economy-arc. This is an air cooled transformer, designed for 110 or 220 volts a. c. with a secondary voltage of 35 volts. It is a step-down transformer, with the secondary coil in series with an

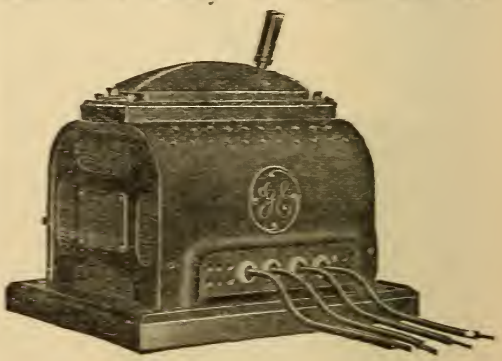


FIG. 9. ECONOMY-ARC

auxiliary winding so connected as to introduce a current in the secondary opposite in direction to that in the main winding and tending to reduce the low voltage current output of the transformer. This auxiliary is equally sub-divided into two parts, taps being brought from each end and from the center to three respective sets of contact clips, between which operates a short circuiting bar, and the coil is so arranged and connected with respect to the main secondary winding as to deliver maximum currents of 30, 40 and 50 amperes in the three positions of the regulating switch for the operation of the arc lamp.

The primary coil is arranged with four leads or taps so as to adopt the transformer for use on 200, 210 or 220 volts. The auxiliary winding is of similar construction and is wound between the main primary

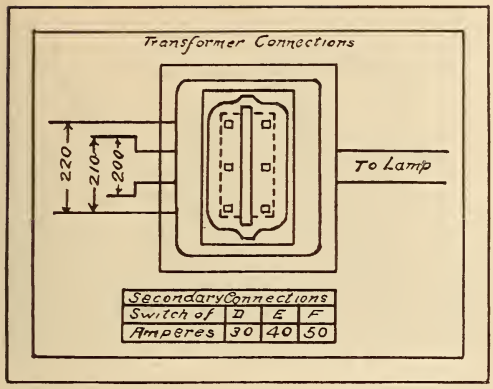
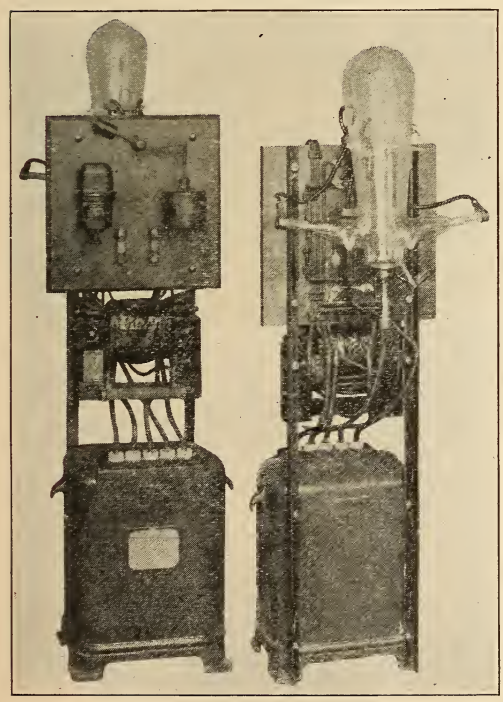


FIG. 10. CONNECTIONS OF ECONOMY-ARC

and secondary coils. Leads from the auxiliary secondary winding are brought out to copper contact plates mounted on each side of the slot through which the switch is moved. The short circuiting bar is constructed of black fibre, upon which are bolted two copper contacts each of which is sufficient width to bridge across the gap between the copper clips, and is so arranged as to maintain the short circuit during movement of the switch and until its corresponding contact piece engages with adjacent clips of the switch, thus preventing fluctuations in the lamp during the period of change. Fig. 10 shows connections.



FIGS. 11 AND 12. FRONT AND REAR OF MERCURY ARC RECTIFIER

MERCURY ARC RECTIFIER

Mercury arc rectifiers for moving picture machines are made in a simplified form, being minus all instruments, all main line and regulating switches, circuit breakers, etc. The rectifier tube is equipped with an automatic shaking magnet in the a. c. circuit to start the arc. The shaker attachment consists of a solenoid coil and plunger in circuit with the alternating current. The electric current passing through the coil causes the plunger to jump up and down, a series of levers communicating this movement to the tube carriage and starting the arc. When direct current begins to flow out of the tube it passes through a relay which automatically cuts the shaker coil out of the circuit.

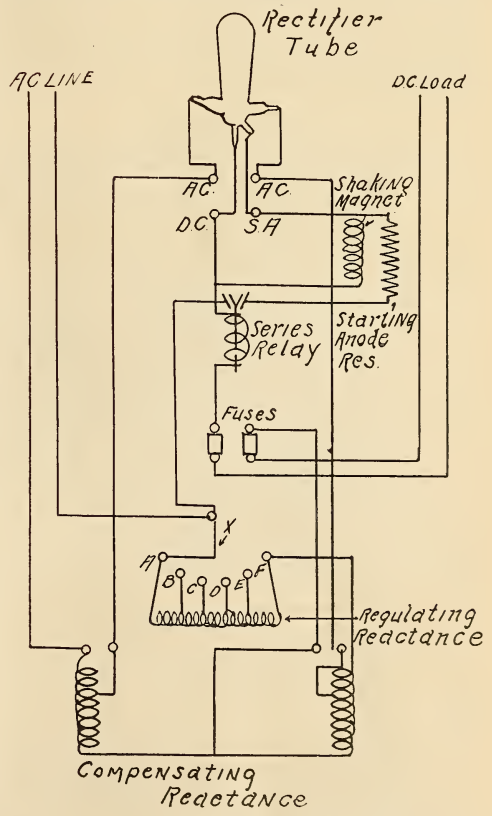


FIG. 13. CONNECTIONS OF MERCURY ARC RECTIFIER

The rectifier tube is of 40 ampere capacity whereas the compensator coils, etc., are designed for 30 ampere outfits. This allows for the initial starting current when carbons of the arc lamp are closed, and where normal current is approximately 30 amperes. A regulating reactance is used to limit the current for the moving picture arc, which reactance is connected in series with the a. c. supply.

The rectifier is designed to start automatically when the carbons of the arc lamp are touched together. The shaking coil tilts the tube and starts the arc as in the mercury vapor or Cooper Hewitt lamp. As soon as the arc is started only direct current is obtained from the terminals. Figs. 11 and 12 show the front and back, respectively, of a mercury arc rectifier. Fig. 13 shows connections.

MOTOR-GENERATOR

The remaining device which may be used for the operation of the moving picture arc is the motor-generator. This is a well known electrical machine, used for many purposes. It consists of a motor and a dynamo or generator mounted on one shaft. The motor takes current from the main line, and as it revolves it drives the generator which latter is so designed and wound as to give the current necessary for the economical operation of the lamp.

Floor Surfacing and Polishing

An entirely new industry has sprung up since application of electricity has been made to floor sanding and polishing machines, one that has been enthusiastically received by architects, contractors, builders, owners and tenants of large buildings of any kind. To the owner of such a machine the field is fresh, and active competition is not yet a problem. These machines will go over a floor and grind down and polish the surface in a manner that cannot be approached by hand methods. They are operated by electric motors which take current from the lighting circuit through a long flexible cord.

Fig. 1 is a surfacing machine only, that is it does not perform the sanding and polishing operations. In front is seen a disk like cutter which bears heavily on the floor and is at the same time revolved by the motor, the latter being carried by a little truck with rubber tired wheels to prevent marring or

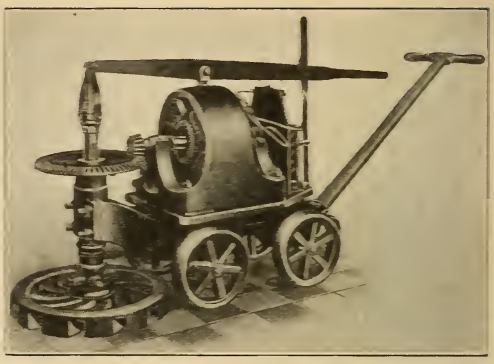


FIG. 1. SURFACING MACHINE

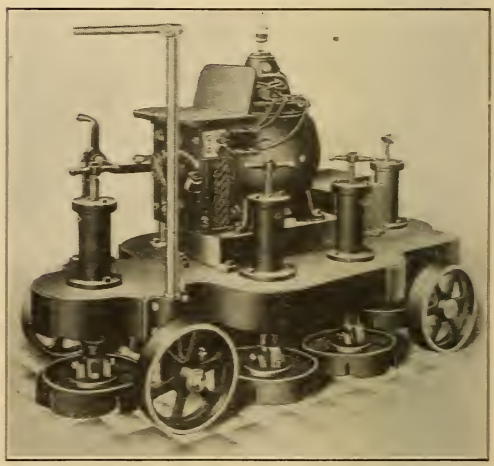


FIG. 2. SURFACING MACHINE FOR HEAVY WORK

FIG. 3. SANDING AND POLISHING MACHINE

scratching. The machine is pushed along over the floor by hand and the lever permits variation of the pressure on the cutting head. The motor is of two horse power. In addition to the surfacing disk a sanding head or special head with carborundum blocks is supplied if desired.

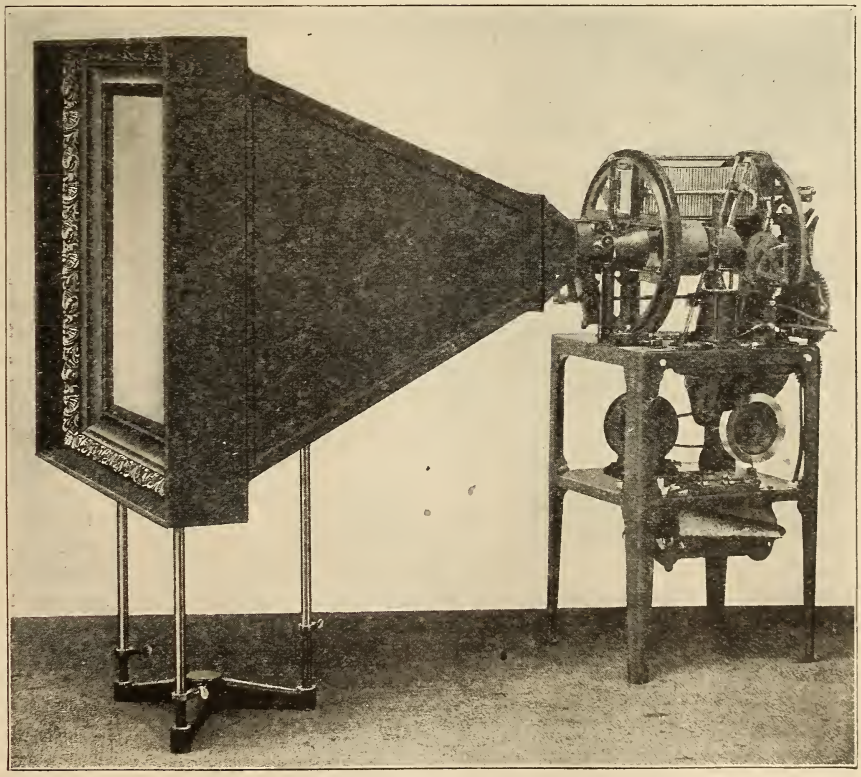
A heavy machine for use on large surfaces of tile, mosaic or terrazzo floors is shown in Fig. 2. The motor which drives the machine and operates the surfacing disks at the same time is of $7\frac{1}{2}$ horsepower. Each grinding head is provided with an independent pressure device. This machine leaves behind it a perfectly smooth even track 33 inches in width.

The sanding and polishing machine shown in Fig. 3 is of quite different design. The sanding and polishing wheels are underneath while in front is a sort of friction roller which is driven by the motor. As this roller revolves it draws the machine along, so that the whole device is virtually self propelling.

The Automaticon

A new form of electrically operated advertising device is represented by the Automaticon which is especially adapted for window display purposes. In front of the machine is a ground glass screen 26 by 28 inches, fitted in a handsome frame. Extending back from this screen is a funnel which excludes all light from the back of the screen with the exception of that which comes from an automatic, self-centering arc lamp situated back of the rear opening in the funnel.

The machine is equipped with 86 slides, showing any subjects desired, and when in operation will automatically display these in succession upon the ground glass screen at intervals of eight to nine seconds. Apparatus which automatically moves the slides in front of the projector is driven by a $\frac{1}{8}$ horse-power electric motor and either alternating or direct current may be used.



THE AUTOMATICON

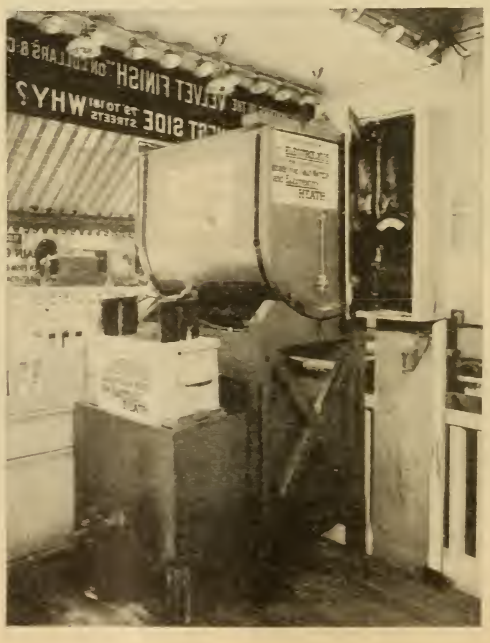
Electricity in the Laundry

By NORMAN G. MEADE

A large shirt factory in Bridgeport, Connecticut, has one of the most complete electric laundry equipments of any similar concern in the country, including electric irons, electrically heated rolls, electric motor drive, etc. The principal feature of the installation is two hundred Simplex irons in use on 150 tables, some of the tables having a double equipment. There are two sizes of irons in use, the largest a 6½ pound iron for general ironing of shirts, and the small or glossing iron weighing three pounds, used for neck and wrist bands. The large irons have a round nose and a round edge, while the small irons have a sharp edge and round nose and rocker-shaped bottom.

The manner of wiring and supporting the cords is quite unique. The mains are run on the ceiling of the floor below, and double branch cutouts placed under each table.

WHERE 150 ELECTRIC IRONS ARE USED



APPARATUS TO PRODUCE CHLORINE BLEACH

The cord support consists of a piece of conduit extended through the floor and supported by a flanged plate. A receptacle with two plugs, one for each iron, is mounted on the support within convenient reach of the operator. Every iron is provided with a special regulator stand, so arranged that when the iron is not in use the current is reduced 33⅓ percent, preventing the iron from overheating, but maintaining a working temperature. In this installation a saving of nearly 30 horsepower per day is

made, as one iron is always on the stand, and the other about one-third of the time, while the shirts are folded and pinned.

In the same room, but not shown in the accompanying illustration, are five electric rolls for ironing bosoms of shirts. The rolls revolve in one direction until the bosom is covered, then reverse, returning to their original position. The reversal is accomplished by a specially constructed commutator.

A large New York laundry is using, with good results, an apparatus which produces chlorine bleach electrolytically, by the dissociation of salt water. This bleach consists of a mixture principally of sodium hypochlorite and caustic soda. The hypochlorite is the active agent when in combination with the soap and oxalic acid used in the washing of linen, and acts as a powerful bleach and disinfectant.

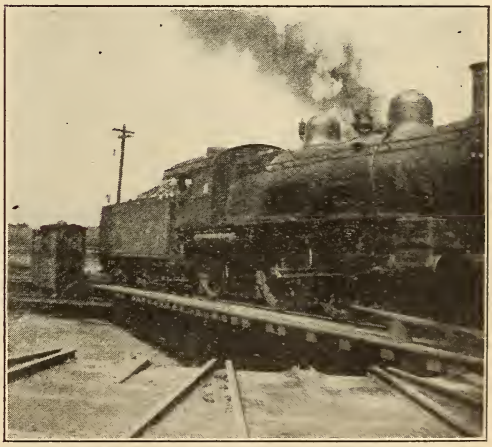
The apparatus consists of a supply tank which contains the salt solution (about 21 pounds of salt in 86.4 gallons of water), an electrolytic vat containing the electrodes, and a tank in which flows the resultant liquid. Edison 120- volt service is applied directly to the electrodes through a reversing switch and ammeter. The reversing switch is used to clean off the electrodes by the reversing of the current after every four hours' running. The flow of the salt water is regulated by a valve from the supply tank and is maintained at a rate which keeps the thermometer in the electrolytic vat at about 95°F., which is the best temperature for the proper formation of the hypochlorites. The current is maintained at as near 25 amperes as possible, and is readily adjusted by the quantity of salt added and by the rate of the flow of the solution.

The method as described above, though more expensive than the common way, which consists of mixing bleaching powder with water, allowing the solution to remain quiet for some time and using the clear liquid from the top for the suds—gives better results and has many advantages over the old method. The solution as obtained with the electrolytic process is so nearly perfect that very little oxalic acid is required in the washing water. One gallon of solution is used with 25 gallons of water for white goods; less solution is used for colored articles. Linen is given a softer finish and no spots appear, as is sometimes the case when the bleaching powder solution is improperly mixed, or when too strong for the soap water; under such conditions holes are often burned in linen and bad stains made. Labor involved in the two methods is practically the same. The cost of bleaching powder is about $8.50 per month as compared with the cost of current and salt at $12.50 per month.

The laundry is doing nearly $10,000 worth of business in a month. The apparatus serves as an advertisement as it is a neat arrangement set up in the front part of the place, easily seen by entering customers, and its sanitary properties being readily apparent.

Electric Turntable

Once upon a time locomotive turntables were laboriously operated by hand. Nowadays in the large shops and yards electric motors are made to do the work. The accompanying picture shows an electrically operated turntable with a locomotive on it ready to be turned. To the left is the cab in which the controlling mechanism is placed to feed a 10 horsepower, 115 volt, direct



ELECTRIC TURNTABLE

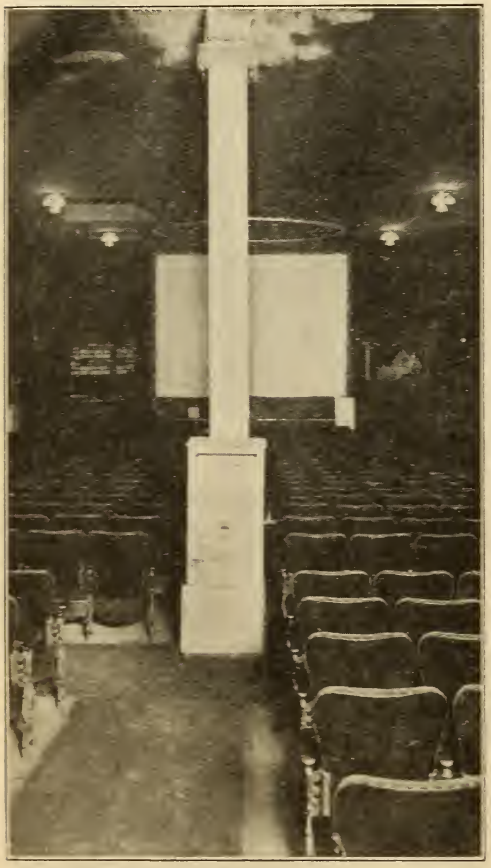
current motor located under the cab.

Current is supplied to the table by wires run underground in a conduit to the center of the table and collector rings are employed to receive the current.

The turntable thus equipped is very economical in time and operation. The old method required from six to eight men, the work being now done by one.

Ventilator and Air Cooler

Artificial cooling of the air in theaters and public halls to make them bearable on hot summer nights is rapidly gaining ground. A new electrically operated apparatus known as the Enpeesee fan is one of the devices by which this may be done.



VENTILATOR AND AIR COOLER

This combined ventilator and cooler consists of a sheet iron casing in the lower part of which is an electric fan which draws the air into a purifying chamber. This chamber contains a pan filled with a chemical solution and mineral wool and drippings from pipes surrounding the ice chest, purifying the air and collecting all dust and particles that may come in through the fan. The air goes out at a temperature 10 to 15 degrees cooler than that at which it is taken in at the bottom.

Concealed Porch Lighting

The main object of a light outside the hall door of a residence is usually to light up the steps so as to prevent any one stumbling, and also, perhaps, to enable those within the house to see the faces of people outside before they are admitted.

This last consideration is often of some moment in country districts, where tramps are a nuisance, says the London Illuminating Engineer, and it is worth while to point out that the position of the lamp in this case requires a little care; otherwise it will actually prevent the accomplishment of the very object for which it is installed. If, as often happens, the lamp is hung immediately outside the door, so as to be in the line of view of a person looking out from the brightly illuminated interior, it merely makes it impossible for him to see anything outside at

CONCEALED PORCH LIGHTING

all. If, however, the lamp is concealed so that he only sees the objects illuminated by it, it serves its right purpose.

The illustration accompanying this article shows one form of porch lighting which

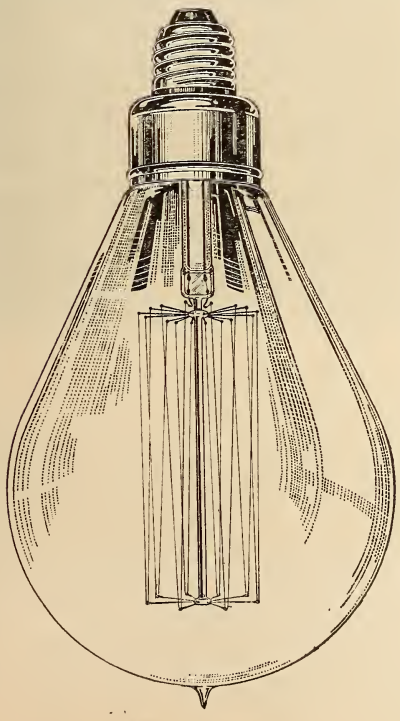
doubtless has some drawbacks, but, is, at any rate, an illustration of the principle on which such lights should be installed.

It will be seen that the sources are quite out of the field of view, being placed in the cornice well above the top of the door. They consist of incandescent lamps with reflectors, so as to concentrate the light downwards, and also throw a certain amount of light on the white surface above the door, which, therefore, assists in promoting the general diffused illumination.

The method shown, besides apparently complying with the utilitarian aspects of the problem, seems to be preferable from the artistic standpoint. Certainly, the general effect produced by the illuminated white moulding, lighted by the concealed sources above the door, is more interesting to the eye than the mere exhibition of an unscreened lamp filament, which is too often considered all that is necessary.

New Tungsten for 220 Volts

The advantages and economy of the tungsten incandescent over the carbon filament lamp have been practically denied to most circuits operating at 200 to 250 volts, because the regular multiple tungsten lamps were designed for the standard voltage of 100 to 125 volts. On these higher voltage circuits—for example, 220 volts—in order to use tungsten lamps at all it was necessary to operate two 110-volt lamps in series, since a 110-volt lamp would be immediately burned out if connected across a 220 volt circuit. Most users of the higher voltages therefore preferred to wait for the advent of the tungsten adapted to their voltage.



TUNGSTEN LAMP FOR 220 TO 250 VOLTS

In answer to this considerable demand, a new style of tungsten has been designed which will operate on 200 to 250 volts. This gives to the users of higher voltages the opportunity for the adoption of the economical high-efficiency lamps for multiple service. This new lamp has the usual tungsten efficiency of $1\frac{1}{4}$ watts per candle power.

The First Wire Tapper

The first telegraph operator in the world to tap a telegraph wire for war purposes was Emmett Howard, who since the early seventies has been a prominent and respected citizen of Memphis, Tenn. This feat was performed by Mr. Howard in September, 1861, while the Confederate army under General Pillow was concentrated at Columbus, Ky., and the Federal army was concentrated at Cairo, Ill., under General Grant.

On September 6, 1861, Grant's cavalry destroyed the telegraph wires between Cairo and Blandville, Ky. After their hasty return to Cairo, Mr. Howard cut the wire a half a mile south of Blandville, and, by using a small relay wire, concealed under the bark of a tree and leaves on the ground to prevent discovery, connected it with an instrument, which he located under a fallen tree in a deep ravine forty feet from the road.

Watching the instrument day and night, Mr. Howard was able to report to General Pillow the movements of the federal cavalry and other important matters for two weeks. At the end of this time he was ordered to report for duty at Columbus. When Columbus was evacuated, General Polk ordered him to remain at Hickman.

He was driven out of Hickman, along with many other citizens, by federal gunboats, but returned the next day and connected a wire with an instrument concealed in the woods about a mile from the town. For three weeks he watched the river and instru-

ment day and night, reporting the passage of gunboats and transports to General Polk at Jackson, Tenn.

After the fall of Island No. 10 Mr. Howard reported to General Cheathan, just before the battle of Shiloh. A week before the fall of Memphis he was ordered to gather up at all stations, including Memphis, telegraph apparatus and material. He reached Grenada with a carload, which was of inestimable value, as nothing in this line could possibly be manufactured in the South.

Mr. Howard ended an honorable career as military telegrapher by transmitting the last official despatch of President Davis, containing 2,000 words, filed at Charlotte, N. C., and addressed to General E. Kirby Smith. This despatch contained instructions as to the disposition of fragments of the armies west of the Mississippi River. The courier detailed to carry the despatch was killed by shots from a gunboat and the message was lost in the river.

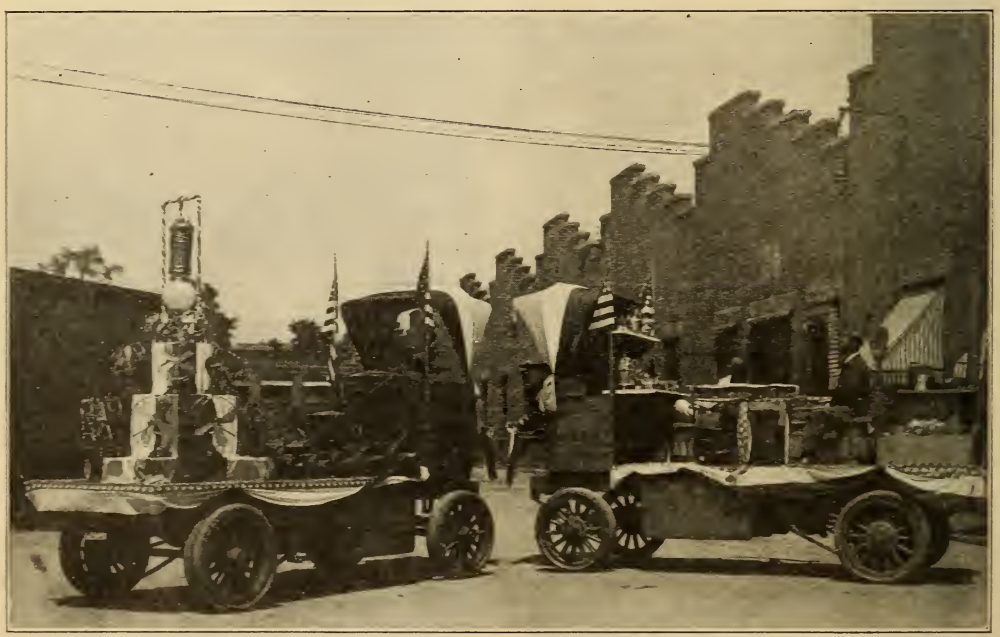
So far as is known and believed, Mr. Howard is the only living person who has knowledge of this interesting and memorable document.

At the close of the war Mr. Howard went to Columbia, S. C., where he accepted a position as manager of the local office of the Western Union Telegraph Company.

In the early seventies he went to Memphis and for twenty-five years held a similar position there. Of late years he has been engaged in the insurance business.—Telegraph Age.

The Modern and The Ancient

On July 5th, Pittsfield, Mass., held a Fourth of July celebration, including among other things a civic parade with decorated floats. Now Pittsfield is the home of a branch of one of the largest electrical manufacturing companies in the country, so it was fitting that this company, to which Pittsfield owes much of its prosperity, should be well represented in the parade. Two unique floats were consequently fitted out, one representing the "Modern and Ancient," typifying the revolutionary effect of the modern use of electricity for household purposes, and the other showing the different appliances for light and power.

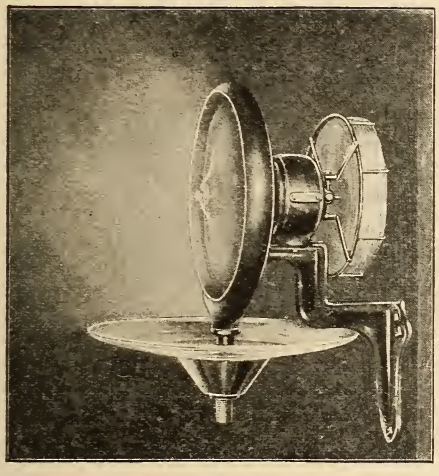


ILLUSTRATING THE ANCIENT AND THE MODERN

The modern and the ancient kitchen were effectively represented, the one being demonstrated by almost every kind of modern electric cooking and heating device, the other by the antiquated wood cook stove.

An Electric Humidifier

All textile fibres absorb moisture, and when reasonably damp are more elastic and work better than when dry. Thus, in former times, weavers set up their looms in damp cellars and today we see how great textile industries have grown up in humid localities such as Lancashire and New Bedford.



AN ELECTRIC HUMIDIFIER

With moist, and consequently elastic yarns, all departments of a textile mill can be run at top speed and a full and perfect production assured, and in favorable weather this is what can ordinarily be done. When cool, dry, brisk days come with the moisture in the air at a minimum we find ends breaking and snapping, machinery stopping, and trouble everywhere, accentuated by the fact that in dry weather fibres in process become highly electrified.

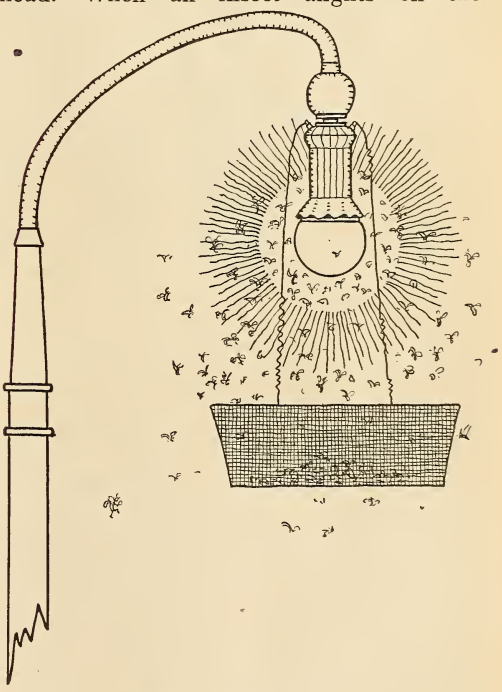
Artificial humidification has been resorted to in order that such trouble may be cured, and by placing humidifiers in the stock room, quilling department and other suitable places much loss may be avoided. One type of humidifier for this purpose is called the Hygrosso and the illustration gives an idea of the appearance of the apparatus. The water, hot or cold and with or without pressure, is fed into the hollow of the vertical revolving disk and reduced to the finest possible vapor by the centrifugal force. At the same time the fan blowing directly over the case distributes the moisture uniformly throughout the room. Both the fan and the disk are mounted on the shaft of an electric motor which is situated between the two.

The units being small and self-contained they may be located in such positions as are best suited for each particular case.

Moth Destroyer

An inventor of Dover, N. H., Charles P. Chesley, has perfected an electrical device for the destruction of brown-tailed moths and other insect pests. These myriads of flying creatures fly mostly by night and are strongly attracted by light.

The device of Mr. Chesley consists of a copper wire basket or frame which is intended to be suspended from the city and town arc lights and to hang about two feet below the light. The mesh of the wire basket is made of positive and negative wires, insulated from each other and deriving their current from the light overhead. When an insect alights on the framework and touches any two wires it immediately closes the circuit and is killed, falling to the ground, or into the basket.



MOTH DESTROYER

A practical demonstration of the device, with honey bees as the victims, is said to have been a great success. The expense of the device is confined to its first cost, which amounts to about $5 per lamp.

POPULAR ELECTRICITY WIRELESS CLUB

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine is devoted to the interests of the Club, and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments

Construction of a Wireless Transformer

ALFRED P. MORGAN

In commercial wireless telegraph stations where alternating current is available the induction coil has been superseded by the more modern transformer. The transformer is also favored by many amateur experimenters since it is more efficient and less expensive to construct.

A one quarter kilowatt transformer is probably the size best suited to the average private installation. It will transmit messages from 50 to 100 miles when used with a proper aerial about 80 feet high.

The electromotive forces developed in a wireless transformer are seldom greater than 15,000–20,000 volts, while those of induction coils range from 20,000 to 300,000 volts. However the currents generated in the secondary of the transformer are much greater and they develop more powerful and penetrating waves than the induction coil. The efficiency also being greater, larger amounts of the initial energy are transformed into oscillations. For these reasons a transformer is always rated by its output in watts or kilowatts rather than its spark length. The spark length of a 250 watt transformer is only 0.25–0.50 inch. The spark of a 500 watt or ½ kilowatt transformer might be the same length but still represent more energy.

There are two distinct types of transformers in use, known as the "open core" and the "closed core," but in this article we shall concern ourselves only with the latter type.

A closed core transformer in its simplest form consists of two independent coils of wire wound upon an iron ring. When an alternating current is passed through one of the coils, known as the primary it generates a magnetic flux, which in flowing through the other coil induces in it an electromotive force. The magnitude of the secondary electromotive force is in nearly the same ratio to the primary inducing electromotive force or voltage as the number of turns in the secondary is to the number of turns in the primary winding. For example, if it is desired to raise the voltage of the 110 volt circuit to 22,000 volts, the number of turns in the secondary must be 200 times as many as in the primary.

It seems almost unnecessary to state here, but it possibly may save work for some not familiar with the underlying principles, that a closed core transformer cannot be used with an interrupter on a direct current circuit. The reason is because the interrupted primary currents cannot die away quickly enough on a closed core to generate sufficient electromotive force in the secondary.

A circular ring of iron wire wound with two coils presents several theoretical advantages as a transformer but would be difficult to construct. The core is usually in the form of a hollow rectangle. The core is built up of thin sheets of very soft iron carefully insulated from one another by a coat of varnish. If the core were solid or not insulated, heavy currents known as eddy currents would be set up in the core and cause great heating. There would also result a considerable loss in the electromotive force and efficiency of the transformer.

One half of both the secondary and primary of a properly designed transformer are

placed on opposite sides of the rectangle in order to reduce the leakage of magnetic flux to a minimum. Do not put thep rimary

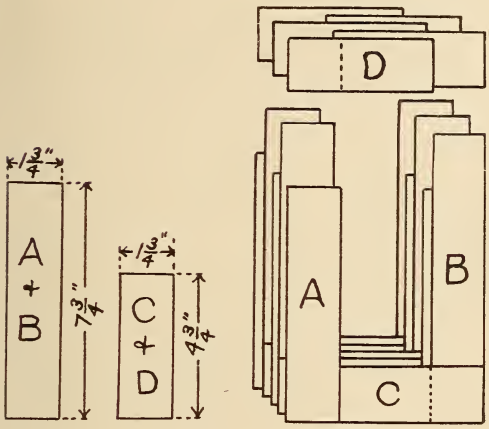


FIG. 1. THE DIMENSIONS OF CORE

all on one side and the secondary all on the other. The only difficulty involved in the first method is the proper insulation of the primary and secondary. This point must be given very careful attention in constructing a transformer.

CORE

The dimensions and assembly of the core are shown in Fig. 1. Strips 1¾ inches wide are cut from soft

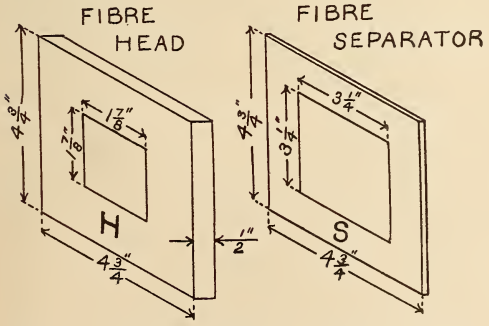


FIG. 2. CONSTRUCTION OF FIBRE HEADS

Russian or Swedish stovepipe iron. Half of them should be 7¾ inches long and the other half 5 inches. Enough of the strips should be cut to make two piles of each size 1¾ inches high when compressed. The completed core will form a hollow rectangle 9½ by 6½ by 1¾ inches.

The strips must be dipped in some good insulating varnish such as P. & B. compound and dried before they are assembled. Both "legs" (the longest sides) are built up with alternate ends overlapping as shown by (A) and (B) in Fig. 1. The short pieces (C) and (D) are slipped between the over-lapping ends and squared up. One end of the core is left open until all the windings are in place. Three or four layers of well varnished linen cloth are wound over the legs preparatory to winding the primary.

PRIMARY

Four fibre heads or cheeks (H) 4¾ inches square and ½ inch thick are made as shown in Fig. 1. A square hole 1⅞ by 1⅞ inches is cut in the centre. One of these is placed on each of the assembled legs as shown in Fig. 3.

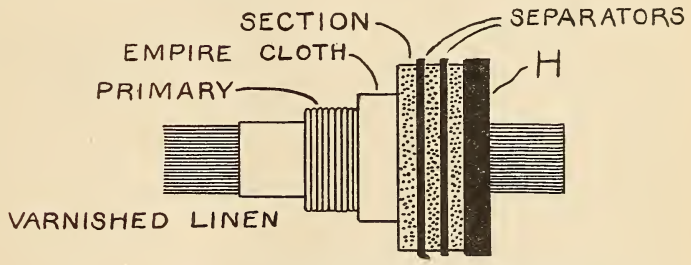


FIG. 3. ASSEMBLY OF PRIMARY AND SECONDARY

The primary winding is 4½ inches long and is wound in six layers, three layers on each leg. The wire used is No. 16 B. & S. gauge double cotton covered magnet wire. About three pounds will be required.

The terminals of the two windings should all lead out through the fibre heads at the same end of the transformer and as near to the core as possible. The windings should not be carried close up to the fibre heads but begin and end about one quarter inch from them. The remaining space is filled by winding in a strip of empire cloth one quarter of an inch wide. A strip of micanite or empire cloth 5 inches wide is wound over both of the primary windings close up to the head until it forms a layer one-half of an inch thick.

SECONDARY

A form must be constructed on which to wind the secondary sections. The sections

are sixteen in number. They are in the form of hollow squares and measure $4\frac{1}{2}$ by $4\frac{1}{2}$ by 7-16 inches outside dimensions. The dimensions and form of the winder are most easily understood from Fig. 4. The secondary sections when mounted on the transformer are insulated from one another by fibre separators (S). (Fig. 2 and

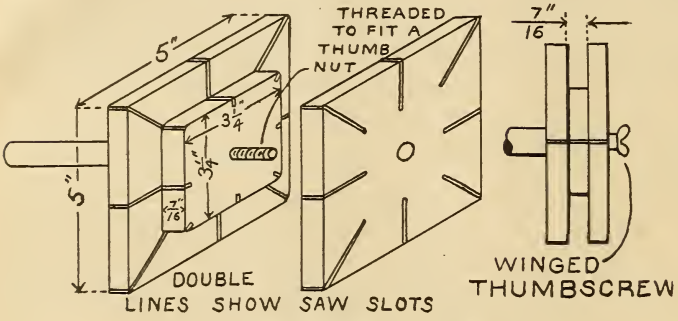


FIG. 4. SECONDARY FORMER

Fig. 6). They are $4\frac{3}{4}$ by $4\frac{3}{4}$ inches on the outside, $\frac{1}{8}$ inch thick and have a square hole $3\frac{1}{4}$ inches square cut in the centre.

The wire used to wind the secondary of the transformer is No. 34 B. & S. gauge enameled copper wire. About ten pounds is required. Cotton covered wire should not be used in this transformer because a sufficient number of turns cannot be secured to bring the secondary current up to the proper voltage. By observing all the instructions and precautions given below no trouble will be experienced in winding enameled wire. The form should be placed in a lathe chuck or in some other similar machine which is convenient and whereby it may be revolved. Saw slots are cut in the flanges and centre of the winder or form so that silk threads may be passed under and around the completed section and tied up so that a possible cave in of the wire is prevented.

The section may then be removed from the form and wound with insulating tape.

The wire must be evenly and carefully wound on the form. No loops or kinks must be wound on. They must first be straightened out or untangled. In case the wire becomes broken the connection must be smoothly made and soldered. Do not attempt to use acid as a flux or to heat the wire by means of a flame. Use a piece of No. 8 B. & S. gauge tinned copper wire as a soldering iron and rosin as a flux. Paraffin some silk taffeta binding such as dressmakers use and wrap the joint or connection with a small piece of it.

The sections as they are taken from the winder must be carefully and distinctly marked with an arrow which points up or in the direction of the winding. The terminals are led out on opposite faces of the sections.

The two methods of connecting up the sections are illustrated in Fig. 5. The second method (B) is the best. It will be noticed that the arrow on every alternate section points down. This does not mean that the wire was wound in the opposite direction on the form. The coils are simply turned around so that the arrows come on a reverse side of the core from the others and point in an opposite direction. This precaution must be taken in order that the current will flow through all the sections in the same direction. The first method (A) does not require this reversal but is not to be recommended.

Careful scrutiny of (B) will show that the inside terminal of one section is con-

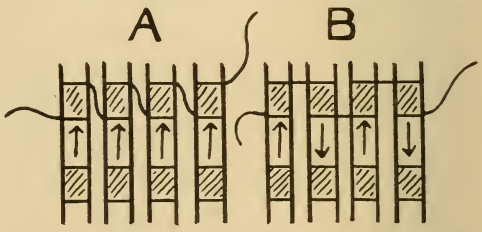


FIG. 5. METHODS OF CONNECTING SECTIONS

nected to the inside terminal of the adjacent section, and the outside terminal of that section is connected to the outside terminal of its adjacent section.

Place eight of the completed and taped sections on each leg of the transformer and interpose one of the fibre separators between each pair. Connect the terminals up as in (B) Fig. 5 and solder them.

Put the remaining fibre heads (H) on the core up flush with the windings and finish assembling the core by slipping the other end strips (D) in the alternating overlapping ends of the legs.

Square the core up perfectly true. The whole transformer is then fastened together by four fibre strips (M), Fig. 6, $9\frac{3}{4}$ inches long, $1\frac{3}{4}$ inches wide and $\frac{1}{2}$ inch thick. A $\frac{1}{4}$ inch hole (P) is bored in each end of the strips. The strips are placed in the position shown in Fig. 6 at the ends of the transformer. Four $\frac{1}{4}$-inch bolts, two of them three inches long and two

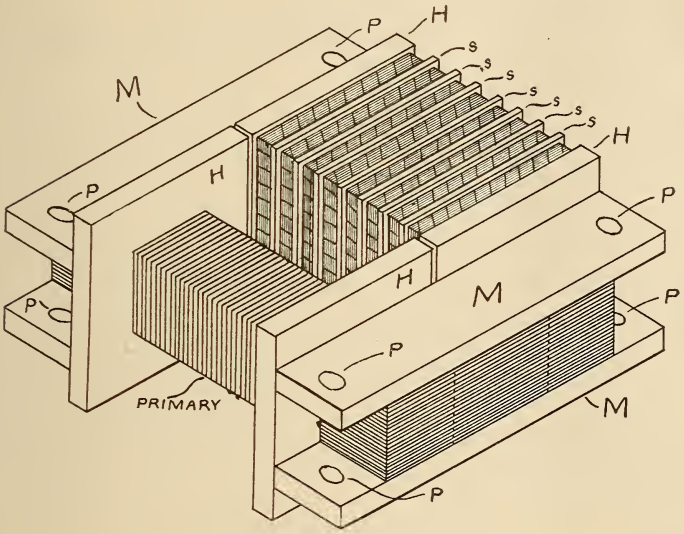


FIG. 6. PERSPECTIVE VIEW OF TRANSFORMER PARTS

$3\frac{1}{2}$ inches long are passed through the holes in the fibre strips. The nuts are screwed on the bolts and tightened until the fibre clamps the core firmly. The two longer bolts should both be placed at the same end of the transformer.

The terminals of the primary are led out to four binding posts mounted on the fibre strips. The secondary binding posts are mounted on pillars. The pillars are one-inch fibre rods, two inches long. A hole is bored in the lower end of each and tapped so that they may be screwed onto the ends of the longer bolts which clamp the strips together. A piece of fibre five inches square and $\frac{1}{8}$ inch thick must be placed between the two secondary windings to form an insulating shield and prevent sparks from jumping from one winding over to the other.

The primary windings should be connected in series. It will then consume from 250 to 300 watts. If the transformer is placed in a box and the box filled with some boiled amber petroleum, the windings may be connected in parallel. The transformer may then be rated at over $\frac{1}{2}$ kilowatt and will transmit over 100 miles, providing the aerial is at least 100 feet high.

Fig. 7 shows a diagram of the complete wiring connections. The ordinary, transmiting helix, condenser spark gap, etc., of a tuned transmitter are connected as usual with the exception that the spark gap must not be placed directly across the transformer terminals as in some circuits but must be in series with the helix as shown. This prevents much of the arcing across the spark gap which otherwise takes place.

The reactance coil is placed in series with the primary of the transformer to steady the current and prevent further arcing of the spark. A suitable reactance coil may be constructed by making a hollow coil of wire and sliding an iron coil in or out. The core should be built up of sheet iron and form a rectangle $1\frac{3}{4}$ by $1\frac{3}{4}$ by

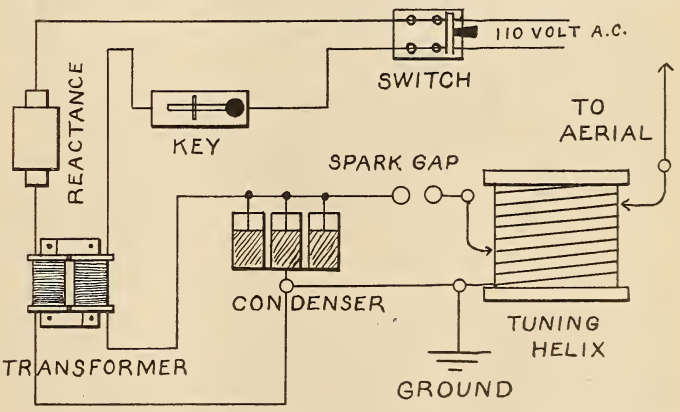


FIG. 7. COMPLETE WIRING CONNECTIONS

eight inches. The winding is composed of two layers of No. 12 B. & S. gauge double cotton covered magnet wire. The layers are six inches long. Make a hollow wooden tube from cigar box wood. The iron core should just slide in and out of the tube. Wind the wire over the wooden tube and leave it on permanently so that it will retain its form.

Five ½-gallon Leyden jars form the right condenser capacity for the transformer when the primary windings are in series. Twice that number must be used when the windings are in parallel.

A glass plate condenser is perhaps more convenient and desirable than Leyden jars. In this case all blistering of the tinfoil is avoided and brushing or corona discharges eliminated. This, besides giving a better spark, makes much sharper tuning possible.

A condenser may be built up from old photographic plates. About twenty-four 8 by 10 inch plates are necessary. The emulsion may be softened and washed off with boiling water. The tinfoil is cut 6 by 8 inches so as to leave an inch margin on all sides. The condenser is assembled as in Fig. 8. The alternate sheets of tin-

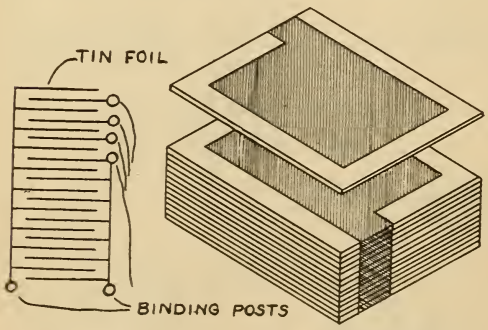


FIG. 8. METHOD OF ASSEMBLING CONDENSER

foil are connected together by a strip of thin copper foil or thick tinfoil about an inch wide. It is a good plan to lead out the last two or three strips on one side separately and connect them to binding posts. The capacity of the condenser may then be adjusted by connecting one or more of the strips in with the rest.

The condenser must be placed in a wooden box about 9 by 10 by 5 inches and poured full of boiled oil. Otherwise the spark would jump around the glass plates. Two such condensers connected in parallel are necessary when the transformer is used to its full capacity at ½ K. W.

When making changes or connections about the transformer be very certain to disconnect entirely all alternating current leads from the primary for an accidental passage of the full secondary current through the body would prove very serious and probably fatal.

Young America at the Wireless Key

The front cover picture of this issue is indicative of what "Young America" is doing in the way of wireless experimental work. The Young Marconi, whom you see in the picture, is C. H. Brubaker of Columbia, Pa., one of the enthusiastic members of Popular Electricity Wireless Club.

All the receiving apparatus is home-made with the exception of head telephone receivers. The sending apparatus consists of a spark coil operated through a water rheostat by 110 volt lighting current, although a transformer will be installed soon which will increase the efficiency of the sending outfit. The sending equipment also includes an ordinary telegraph key, home-made spark gap, home-made brass wire helix and adjustable leyden jar condensers. The sending range is about three miles.

For receiving there is an enameled wire, single-slide tuning coil, potentiometer, electrolytic, carborundum and molybdenite detectors, 1500 ohm receivers and a variable condenser.

The young experimenter has also rigged up an ingenious switchboard, part of which shows in the picture, to control the different apparatus. It is provided with the necessary switches, test lamps, fuses, etc. Meters will be put in later.

With this apparatus messages have been received from the large stations within its range, up to 400 miles.

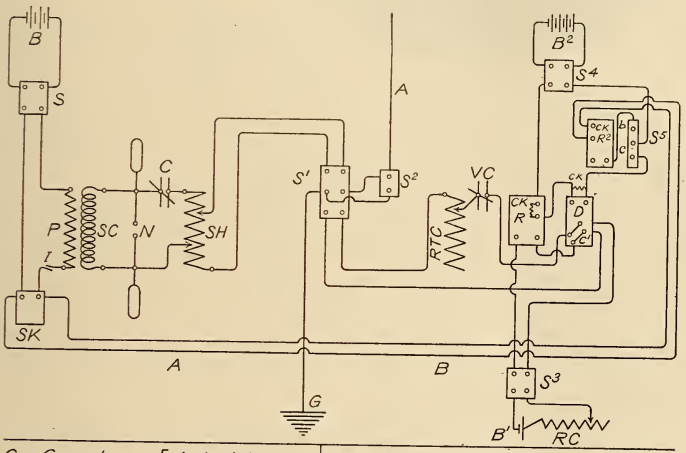
It is stated that the wireless telegraph station on the Eiffel tower in Paris has been receiving messages from the station at Glace bay, Canada, a distance of 3,250 miles. A new installation is being fitted at the Eiffel tower, by means of which it is hoped to establish wireless telegraphic communication with Saigon (Cochin-China), a distance of 6,800 miles.

Auto-Spontaneous Repeating System

By DAVID MARCUS

The object of this system is to repeat spontaneously and automatically to the operator of the transmitting station sending the message an exact duplicate of the signals being received at the other station.

Receiving stations experience more or less difficulty in receiving a perfectly intelligible message, due to the unfavorable condition of the "magnetic waves," especially if the message be of a long distance transmission. With the present systems of wireless telegraphic communication the operator at the transmitting station is absolutely ignorant as to the condition of the receiving capacity of the station with which he is communicating. It therefore often happens that the transmitting operator is several times requested to repeat his message, and if his receiving instruments are improperly balanced sensitively, he fails to receive, or intelligently understand the sender's complaints.



G – Ground
B – Battery [A-Aerial R-Relay]
S – Double Pole Single Throw Switch
SK – Signal Key
I – Interrupter
P – Primary of Induction Coils
SC – Secondary of " "
N – Zinc Spark Gap
C – Adjustable Condenser
SH – Sending Helix
S' Double Pole, Double-Throw Switch
S² Single Pole, Single-Throw "

RTC – Receiving Tuning Coil
VC – Variable Condenser
D – Decoherer
C' – Coherer
R² – Repeating Relay
S⁵ – Single-Pole, Double-Throw Switch
S⁴ – Double Pole, Single-Throw Switch
B² – Batteries
S³ – Double-Pole, Single Throw Switch
B' – Battery of Single Cell
RC – Resistance Coil or Rheostat
CK – Choking Coils

CONNECTIONS OF AUTO-SPONTANEOUS REPEATING SYSTEM

To entirely remove the above obstacles, and to bring both operator at the transmitting station and operator at the receiving station in closer relation as to the condition of each other's transmitting and receiving, the writer has invented the following system:

Connect up instruments as shown in Fig. 1, (A) representing the transmitting station, and (B) the receiving station. By carefully tracing and studying the various connections the reader will easily find that the only important change from the various systems now employed is in the use of a second relay with additional switches to throw in or cut out the repeating relay.

When the station is not transmitting, the single pole, double throw switch (S^5) should always be kept closed on the contact (b), which from the wiring in the diagram puts the second relay (R^2) in series with relay (R) and the decoherer circuit (D). Now if you desire to transmit signals, all that will be necessary is to throw the switch (S^5) on the contacts (c) which cuts out the repeating relay (R^2).

The action of the system will then take place as follows:

You desire to call a friend or some other wireless station with a call letter P. E. and a wave length of 400 meters.

Regulate your transmitting tuning coil to the proper wave length, and throw the switch (S^5) on the contact (c), thus cutting out the repeater. Now call your station, also giving them your call letter and wave length. If you are in proper tune with your distant station and both transmitting capacities of the required radius, you should receive a duplicate of the exact call

you have made. For you will understand that the switch (S^5) at the receiving station that you are communicating with has the repeating relay (R^2) in series with the relay (R) and the decoherer (D).

As it is customary to call a station at least three times, a short space of time will be required by the operator to properly adjust the tuning coil of the transmitting station, to the station that you desire to communicate with, in order that the regulation of the signal may be in tune with your receiving capacity. For your receiving capacity may be of 600 meters wave length, while that of the station you are communicating with is only 400 meters. It is therefore advisable to make each call at an interval of at least one minute. The operator of the transmitting station will therefore only receive one or two repetitions of his call, depending on the promptness of the operator at the other end in adjusting his apparatus. If the coherers at both stations are properly adjusted no difficulty whatsoever will be experienced in receiving correct repetitions. Should the repetition at the transmitting station be received orrectly, the operator may continue sending the message, at the same time directing his attention to the receiving apparatus and noting whether the repetitions are just as those transmitted. If they are not the "error" signal should be inserted and the word again repeated until the correct repetition is received.

When the message is completed and the "finished" signal given, the switch (a) of your receiving station should be adjusted on the contact (b), then await the final O. K. from your distant station, which will be repeated back to him as an acknowledgment from you.

RECEIVING APPARATUS

It will be necessary to enclose the coherer in a metal case with a wire leading from the case and connected to the ground. This will ground the oscillations which otherwise would infringe upon the receiver and cause confusion of the incoming signals.

Switches (S^1) and (S^2) form a novel arrangement to ground the aerial when the station is not in use, or in case of electrical storms. To ground the aerial it is only necessary to close the switch (S^2). When operating, (S^2) must always be open, and (S^1) adjusted, depending on the will of the operator.

Wireless Works Best By Night

It is one of the many marvels of wireless telegraphy that the ether waves which carry its messages, unlike light waves, suffer no absorption in mist or fog. Quite the opposite, in fact, is the case, for the effect on them of clear sunshine is so marked that they can be sent with equal initial power less than half the distance by day as by night. For this reason press dispatches and long-distance messages sent by wireless telegraphy are, whenever possible, committed to the ether waves after sunset, when they may be transmitted to a much greater distance.

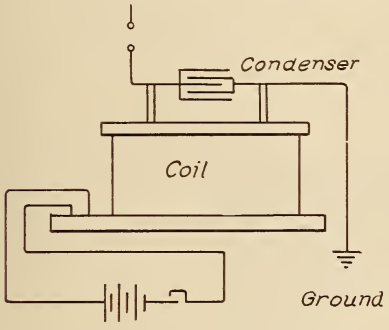
TRANSMITTING APPARATUS

WIRELESS QUERIES

Spark Coil and Condenser

Questions.—(A) Please give data for a six-inch spark coil which will use no finer wire than No. 30 B. & S., S. C. C. for the secondary and give a big fat spark. (B) What voltage is required for above coil? (C) If a coil is connected as shown in the diagram will it be damaged? (D) What condenser is best to use, a jar or plate condenser? —C. S., Newark, N. J.

Answers.—(A) We refer you to the article on "Spark Coil Construction and Operation," in the May to August issues.



SPARK COIL CONNECTIONS

(B) Approximately 12 to 15 volts and five to six amperes.

(C) No, but we fail to see where any increased results would be had from this manner of connecting.

(D) Either the Leyden jar or glass plate kind will answer.

Wave Length; Condensers

Questions.—(A) How is a wave length measured? (B) Which are best, Leyden jars or a common layer condenser with 50 sheets of tin foil 5 by 6 inches?

Answers.—(A) The proper measurement of wave length is usually found by use of a wave meter, which is especially calibrated for this purpose. A rough method that is prevalent at the present is to multiply the aerial length by four. Considering that the height of the aerial is 50 feet the wave length, according to this rule, would be 200 feet.

(B) This depends on the purpose for which the condenser is to be used. If for use across the vibrator contacts of a spark coil, the paper type would answer, but across the secondary in the closed circuit set the Leyden jar should be used, as the paper type could not withstand the high voltage current.

Coherer; Leyden Jars

Questions.—(A) Will a receiving set embodying a coherer fastened to a slowly revolving toy motor shaft, so as to dispense with the decoherer, a 150 ohm standard telegraph relay and a sounder, work on a line about a mile long, with a one-inch spark coil at the transmitting station? Coherer made of brass tube about two inches long, filled with powdered antimony. (B) Can I increase my sending distance any by bridging two small Leyden jars across the secondary circuit, or would it be better to have them in primary circuit? (C) Does an aerial necessarily have to be made of many bare wires strung between two poles, or would a lightning rod serve the purpose if severed from the ground?—E. K. O., Essex, Mass.

Answers.—(A) Coherers have been made in the manner you describe, but none have ever proven successful. The ordinary metal filing coherer will answer, as it is easy to construct and handle. With a set built up with a one-inch spark coil at the sending end, a 150 ohm relay at the receiving end, you should be able to work up to about one-half mile, considering that the aerial is about 40 feet in height.

(B) To increase the sending efficiency, the Leyden jars should be bridged across the secondary terminals and spark gap. All spark coils are equipped with the condenser across the vibrator contacts, therefore, it would be useless to connect the jars at this point.

(C) No, but for more efficient results we would recommend an aerial of this type. The lightning rod scheme would answer for short distance use, but can not be recommended.

Coil and Aerial Dimensions

Questions.—(A) How large a coil will be needed for sending wireless messages a distance of two miles over the resident portion of this city? (B) How high an aerial? Would it work successfully with an aerial under 35 feet high? (C) Would the coil used be efficient for experients with X-ray tubes? (D) Would a 75 ohm relay be sensitive enough?—C. C. H., Indianapolis, Ind.

Answers.—(A) We refer you to the article "Spark Coil Construction and Operation" May to August issues. A two inch coil built up as described would probably be of sufficient capacity.

(B) The aerial should be at least 50 feet high. The 30 feet aerial might answer, but the higher one is recommended.

(C) No.

(D) Yes, provided a well made sensitive coherer were used.

Rheostat; Detector

Questions.—(A) How can I construct a 300 ohm regulating rheostat? Kindly show diagrams. (B) Where can I purchase silicon? (C) What metal can be used in a detector in the place of silicon?—M. E. S., San Francisco, Cal.

Answers.—(A) You fail to state the use for which the rheostat is intended. If for use in a wireless telegraph receiving circuit as a potentiometer, build up by winding 2½ pounds of No. 22 S. S. C. German silver wire on a circular wood frame that is three inches in diameter. The frame is now mounted on a suitable base and one of the leads connected direct to a binding post. A portion of the winding is scraped bare all the way down the frame, and a sliding contact counted so that connection may be made with the different turns. The sliding contact is connected to a binding post mounted on the base.

(B) Apply to some of the dealers advertising in this magazine.

(C) Carborundum, Molybdenite, etc.

Wireless Sending Parts

Questions.—(A) Could I use a regular Morse telegraph key in sending messages with a 12-inch spark coil? If not, what kind of key should I use? (B) Can you give me any information of how to build a tuning coil to be used in tuning in most stations around San Francisco? (C) I am using an aerial 70 feet high; two horizontal wires each 100 feet long. Would that do satisfactory work at a distance of 250 miles? (D) Could I use a relay to work a sounder in above distance?—R. J. Loewe, Visalia, Cal.

Answers.—(A) Yes, but we would suggest that you get one with somewhat heavier contacts.

(B) Make the tuning coil as follows: Make a cylindrical insulating frame, wind around the outside 115 turns of bare, tinned copper wire, No. 18; turns 3-32 inch apart. Provide sliding contacts to work up and down the frame so as to touch any of the turns of wire.

(C) Yes, for receiving.

(D) A liquid detector and telephone receiver should be used.

Winding a Spark Coil

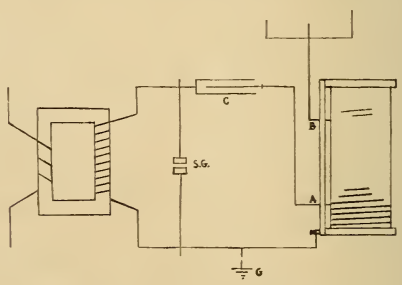
Question.—I have a core four inches long by ¾ inches in diameter. Please tell me how much wire to use, the kind and also the length of spark possible. —A. H., Meadville, Pa.

Answer.—For general details see serial "Spark Coil Construction and Operation." For your coil use five ounces of No. 18 wire on the primary, and three-quarters of a pound of No. 36 on the secondary. This should give a quarter inch spark. The secondary need not be wound in sections. For the condenser use 25 sheets of tinfoil 3x1¼ inches. This coil will operate well on four volts and two amperes.

Transmitting Tuning Coil

Questions.—(A) Please give me dimensions of a transmitting tuning coil that can be used with a ¼ K. W. transformer? (B) What does 100 meters wave length mean in speaking of a receiving tuning coil? (C) How is a transmitting tuning coil used? —L. R., Madison, Ill.

Answers.—(A) A good, simple sending coil can be made by securing a wooden or paper drum about eight inches in diameter by 12 inches long and winding it with 30 turns of No. 32 copper ribbon ⅛ inch wide. The turns should be equally spaced and shellacked. After the coil is thoroughly dried, a bare place about ½ inch wide, should be scraped along one side of the coil. Two



TUNING COIL CONNECTIONS

wooden disks 8½ inches in diameter and one wood strip 14x½x¼ inches should be made next. The ends are screwed on and the strip placed over the bared place on the coil. A binding post is connected to one end of the winding while the other two connections are made by inserting two pieces of spring brass, bent in the shape of a V, under the wooden strip. (See diagram.)

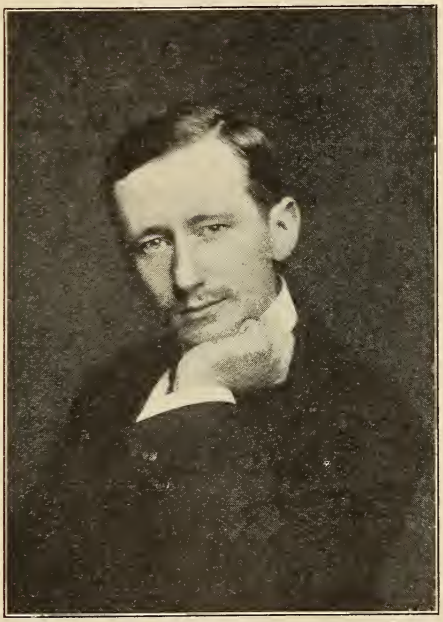
(B) A tuning coil having a wave length of 100 meters is one having turns enough to respond to a wave 100 meters long. A coil of this size is not of much practical use, as all commercial stations use a wave longer than 100 meters.

(C) See drawing. Put (A) on about four turns, then adjust (B) to where a hot wire ammeter, in series with the aerial, gives the maximum reading. The proper working place can be found by a little experimenting.

Electrical Men of the Times

GUGLIELMO MARCONI

Marconi did not invent the wireless telegraph, as is popularly believed. He, however, performed the great service of making the first practical application of wireless telegraphy to commercial uses. In other words, Marconi is a human benefactor by actually leading the way in the development of a new art which is becoming increasingly useful to man in its practical applications.



Wireless telegraphy is simple in its fundamental principle. It involves the erection of a receiving instrument or station and a transmitting instrument or station, both electrically grounded to the earth from and to which messages may be sent through the vibratory ether. No insulated conductor is necessary, but an electrical connection with the body of the earth. The message is sent flying out of the transmitter by the generation of an electrical spark, like a lightning flash, in a storm of contending elements, to be caught up by the antennæ or feelers of the attuned receiving instrument. But it took a Marconi to even dare to suppose that these ether vibrations, which others had discovered, could be generated and controlled.

Guglielmo (William) Marconi was born only thirty-four years ago, in the Italian city of Marzabotto, near Bologna, of an Italian father and an Irish mother. His father gave him a Roman heritage, providing strength for his conquests of nature. His mother was a highly cultured woman, a talented musician and member of the celebrated Guinness family of Dublin.

He became interested and began experimenting in electricity as a boy, and he was given a good school and college education. He was but fifteen when be began to devise instruments to show that an electric wave, if started in any given direction, will follow an undeviating course without need of a wire or other conductor. He continued his electrical work from his love of it, and he received his greatest reward on that memorable day, December 12, 1901, when he received at Signal Hill, Newfoundland, three little clicks, the dots of the letter "S", signalled by pre-arrangement rom the coast of England, two thousand miles across the waters of the Atlantic.

The inventor is a man of medium stature, high strung, yet deliberate and of great nervous and mental activity. His capacity for work is best measured by his signal achievements, in his mastery over opposing forces. He is a man of science and imagination as well as an inventor, and, moreover, a practical business organizer, being the controlling head of the Marconi Wireless Telegraph Company now operating for the conduct of business in the United States and leading countries of Europe.

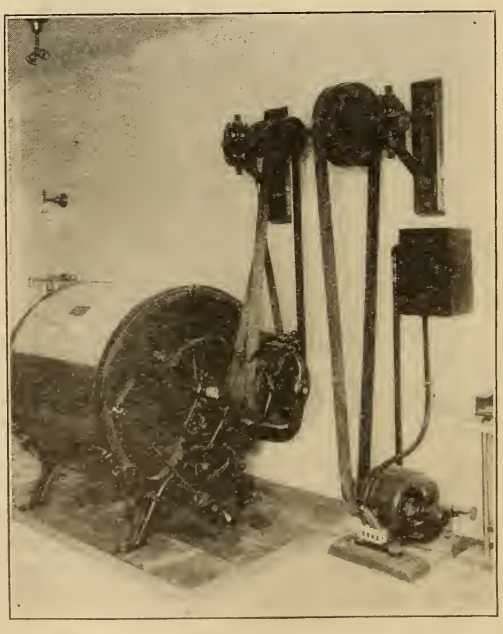
Marconi is a quiet man, of a keenly sensitive disposition. He doesn't speak much. But he uses the power of directed thought upon the work in hand. He overcame great material obstacles, laboring faithfully into mastery at last, and a new application of knowledge has been made to add strength and zest to the life of man.

ELECTRICITY IN THE HOUSEHOLD

A Modern Residence Laundry

The servant problem has been talked about, it has been written about and cartooned about; and it is still with us. But there is one kind of servant that never gives any trouble, is ready on the instant, never takes a day off at the wrong time and never "gives notice." That servant is electricity.

No department in the household perhaps gives rise to more heated discussions or is such a hotbed of rebellion as the domestic laundry; that is, under the old conditions. But now that electricity can be made to perform, with minimum labor, what was once the drudgery of housekeeping, one of the bones of contention has been removed.

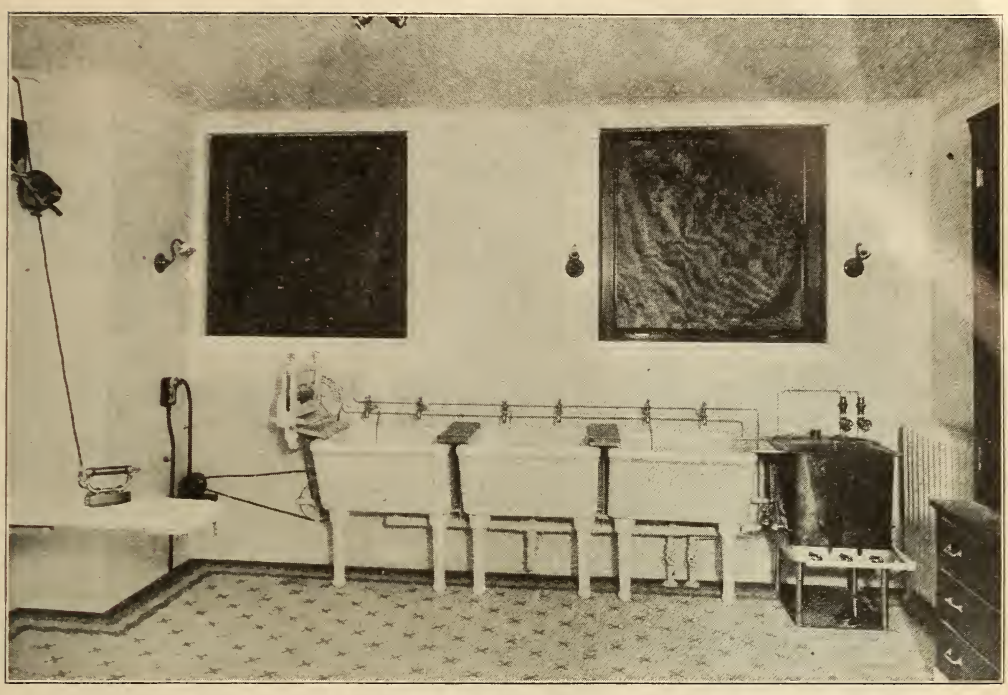


MOTOR OPERATED WASHER

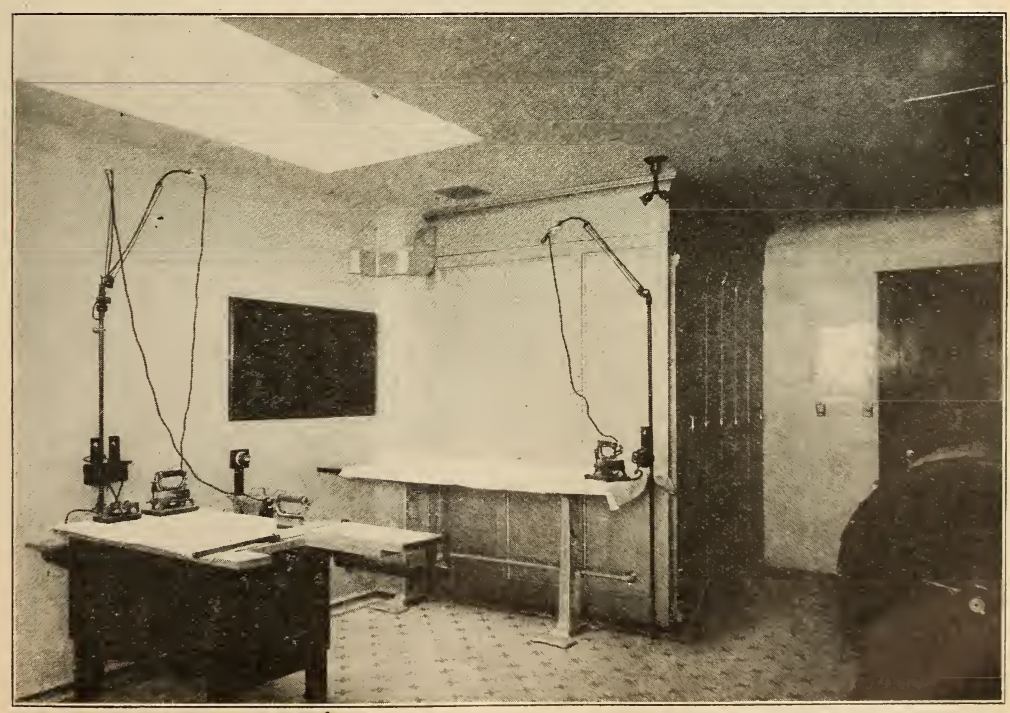
The three pictures which are shown here illustrate what a modern residence laundry should be. Introduce a servant to a neat basement apartment so equipped and the chances are you will not hear, in abrupt but expressive language: "What! Do the laundry work? Not for mine."

As far as possible every operation is performed by the magic current. The revolving washing machine is run by an electric motor and is started going by the simple throwing of a switch. When the clothes are clean they are transferred to the rinsing tanks of shining enamel, with hot and cold water always available. After passing through the tanks there is waiting at the last one an electric driven wringer ready to perform, at another turn of a switch, another of the old time disagreeable and tiresome tasks.

Then there are artificially heated drying cabinets to take the place of the dust and soot laden "four winds," and last of all the electric irons for all kinds of work from coarse articles to the finest ruffles. The arrangement of these irons is very convenient. The conductors which bring the current from the lighting circuit are brought up through tubes and are then carried out on flexible arms.



RINSING TANKS AND MOTOR DRIVEN WRINGER



ELECTRIC IRONING APPARATUS

Advantages of Vacuum Cleaning

Discovery of germ life and its effect on health was one of the greatest steps in medical science. The discovery, isolation and finally the method of combatting certain specific germs which caused some of the most dreaded diseases of the past, such as diphtheria for instance, has resulted in the reduction of the mortality of these diseases to comparative insignificance. This knowledge has also revolutionized surgery. No more striking example of the respect with which these foes of human life are held by the medical fraternity may be had than to go through a modern hospital. There are no wall paper, no carpets, no sharp corners in the walls or ceilings even, for everything is made to be scrubbed and sterilized and scrubbed again and again, with endless monotony, in the constant warfare with unseen inhabitants of the germ world.

In our own homes these precautions cannot all be taken without making rather dreary habitations. We like rugs and carpets, pretty pictures, tapestries, curtains and a hundred other things that catch and hold dust, and wherever there is dust there also are germs—countless millions of them. The only thing that remains, therefore, is to make constant war on dust and it is just there that the broom or carpet sweeper and the feather duster are hopelessly lacking in efficiency. They stir up any amount of dust only to leave it in a little different place till the next sweeping.

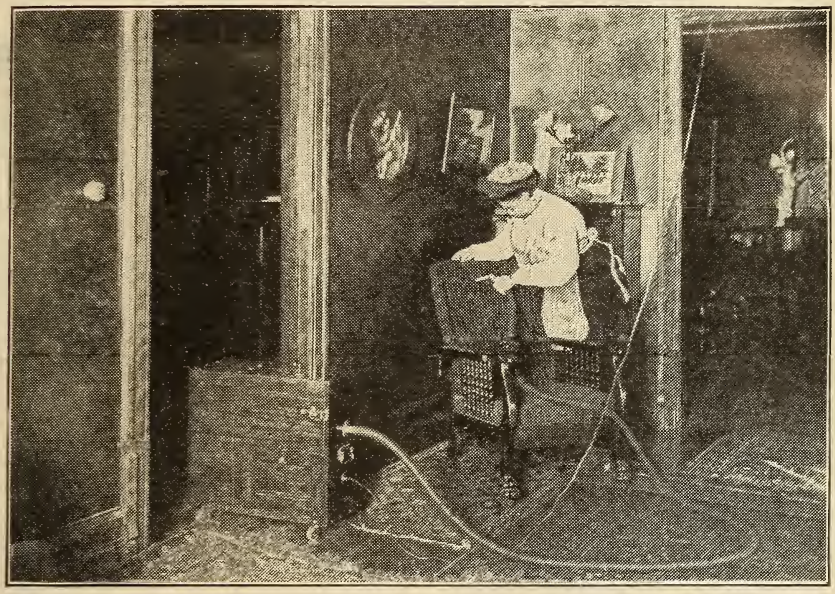
A few years ago vacuum cleaning came into vogue. At first we only saw it in connection with installations of considerable size, with gasoline engine and suction pump mounted on a truck in the street and with long lines of hose running up into the windows of the building undergoing the cleaning process. Then, as in almost everything else, electricity was called to the task and portable outfits were made which could be owned exclusively by the householder. All that is required in the operation of these devices is to attach the electrical conductor and plug to the lamp socket and turn on the current. The motor then operates the vacuum pump which is attached through a short hose to various "tools" adapted to clean carpets, upholstery, curtains, etc.

CLEANING CARPETS BY VACUUM PROCESS

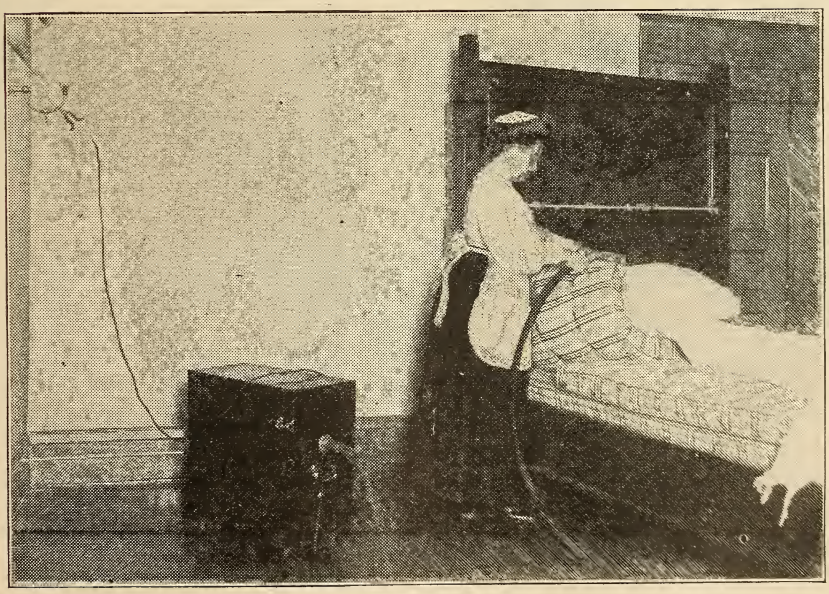
The pictures herewith show one of the newest types of electric vacuum cleaner in

operation. Mattresses may be renovated, upholstered furniture cleaned, dust sucked up through the carpet; all the refuse being drawn through the tube into a receptacle in the cabinet. Two cents worth of electricity an hour will operate it.

A range of from 0 to 12 inches of vacuum can be obtained with this machine. Twelve inches of vacuum means that if the suction were applied to the top of a tube standing with its lower end open in a dish of mercury the pressure of the outside atmosphere



DUST IS READILY REMOVED FROM UPHOLSTERY



DOES THE WORK OF A MATTRESS RENOVATOR

would raise the mercury in the tube to a height of 12 inches, or corresponding approximately to six pounds pressure. Twelve inches of vacuum is sufficient to draw the dust out of the heaviest carpets but will not injure the nap. For light work such as delicate curtains, etc., a less vacuum may be obtained.

Electric Lighting in Ornamentation

Houses of the present time contain many architectural features which lend themselves readily to ornamentation by electric lamps. Millwork plays an important part in the plans in the present time, and columns, newels, etc., are utilized at various points in rooms, halls, arches and arbors, where the brilliancy of electric lamps may have full play. Some modern homes are marvelous in this respect, and the business of designing such features has almost reached the dignity of a profession.

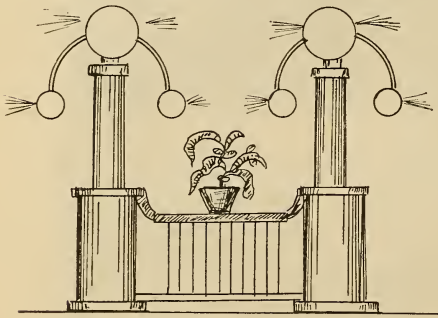


FIG. 1.

In the construction of some of these combinations, the key-note is simplicity. In the designing of some others, the intricate plan is quite conspicuous. An attempt is often made to introduce grille work, scrolls, stars, etc.

Various tastes have to be accommodated. Hence, in some cases we find that the set-piece is of the order shown in Fig. 1. This stands prominently in a hallway. It serves as a lighting ornament. The hardwood columns are all well polished. There is a section of lattice work intervening, and the columns are furnished with the three light globes each. The wires extend along the floor line, then up the line of the posts to the lamps.

On some special occasions signs may be introduced at little expense, for church festivals, etc. In one instance, the archway under which the guests passed was arranged with three columns of pine wood on each side as in Fig. 2. The sheet metal

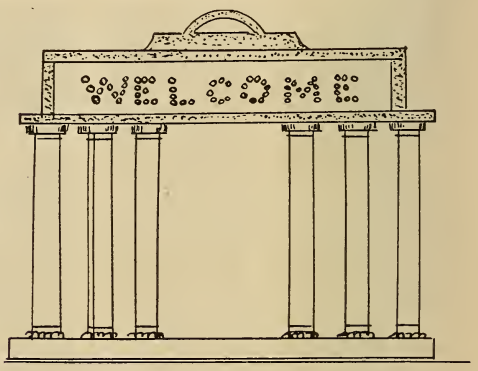


FIG. 2.

front sign was installed on a panel supported by these posts.

Sometimes the decoration involves the use of a single strong lamp on the top of a post as in Fig. 3.

Heavy timber work shows off to good advantage where there is good illumination.

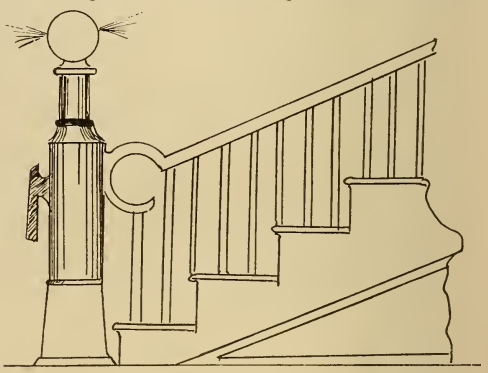
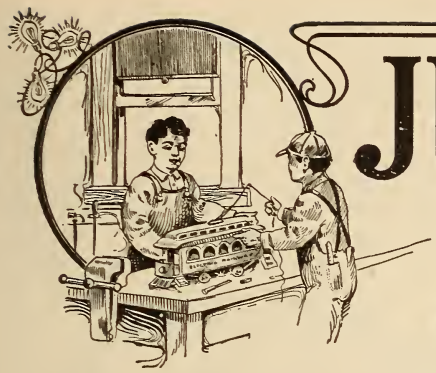


FIG. 3.

The tendency now-a-days is towards more light. This fact is noticeable in all parts of the country. The people are getting educated to a point where a more intense brilliancy is demanded. The owners of homes are not satisfied with merely a well lighted interior but wish to have a blaze of light streaming from the windows. Light is cheaper now than it used to be and it is not so essential that we curtail at every point. The man of the house who used to follow about turning off every possible light, now often lets them burn simply for the satisfaction and good cheer derived.



JUNIOR SECTION

Construction of Ring and Core-Type Transformers

By LOUIS H. ROLLER

Many persons find it difficult to see why alternating current, instead of direct, is used so extensively for light and power purposes. It possesses such peculiar characteristics, and to the amateur is so difficult, both of comprehension and computation, that it appears useless alongside of direct current. But the one feature of alternating current in which it excels direct, is the economy and ease with which it is transformed from one potential or voltage to a higher or lower one. So the experimenter who desires to work with alternating current, will find a transformer the simplest and most fundamental piece of apparatus with which to start.

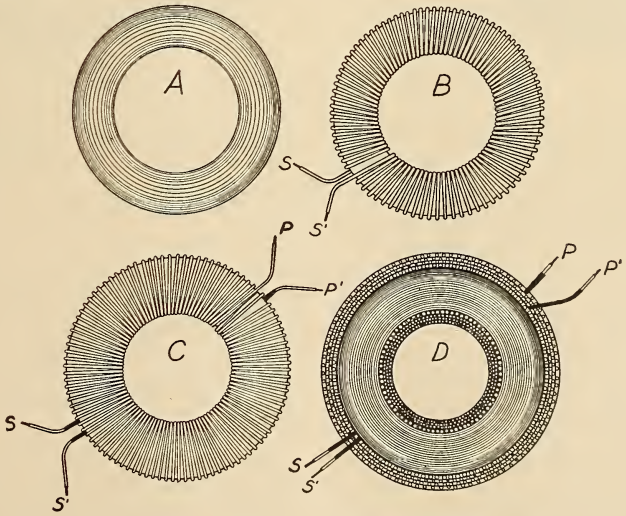


FIG. 1. STEPS IN CONSTRUCTION OF RING TRANSFORMER

Fig. 1 shows the steps in the construction of a ring wound transformer; (A) is the core of soft iron wire; (B) the secondary winding, and (C) the primary winding, both of copper magnet wire. (D) is a cross-sectional view of complete transformer.

The core may be considered as the foundation of the transformer, so its construction will be gone into in detail. Fig. 2, in two views, illustrates the winding of the core. Upon a cylindrical form about four inches in diameter and at least three inches long, made of wood pipe, or a tin can, a layer of heavy string is wound, its use being to release the wire from the form after winding. Over this string a layer of paper is put on, and then a few turns of the soft iron wire, which should not be larger than No. 20, are wound on. At this point the binding strings, (A), (B), (C) and (D), Fig. 2, should be slipped under the turns of wire already on, and the remainder of the winding finished. Then the binding strings should be tied up, and the release string pulled out, leaving the ring

of soft iron wire loosely on the form. This ring is kept from falling apart during handling by the binding strings tied around it; to keep it together permanently, make it solid, and insulate it, several layers of cotton or friction tape are wound on tightly, and the core is finished.

This core should have about three square inches cross-sectional area, and will require about three or four pounds of soft iron wire.

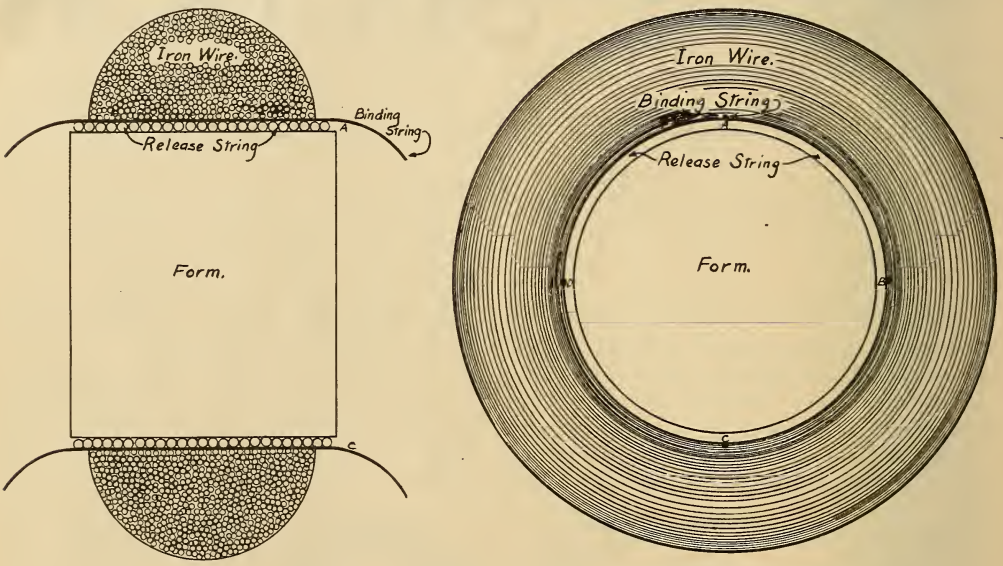


FIG. 2. WINDING OF THE CORE

It should be as solid as possible, but need not be wound in perfect layers, nor need it be of one continuous piece of wire.

Now the secondary is put on the core. This winding consists of one hundred turns of No. 14 B. & S. double cotton-covered magnet wire, and is wound on as shown at (B), Fig. 1. About one pound of wire will be required for it. The primary consists of 550 turns of No. 20 B. &. S. double cotton-covered magnet wire, and is wound on the secondary, being insulated from it by a layer of tape. This winding will take about three layers, (C), Fig. 1, and will require about one and a half pounds of wire. Each layer should be insulated from its neighbor by taping, and a layer of tape over the whole winding will finish the transformer.

The easiest way to do this winding is to calculate the length of wire required, wind that much and a little more on a spool small enough to pass through the hole in the ring, and by passing the spool through and around, and carefully guiding the wire as it unwinds from spool onto core, no difficulty should be experienced in obtaining a good winding. The leads (S, S′) (P, P′) should be thoroughly taped where they lie next to other wires as they come out from their respective windings, and in putting in the windings care should be exercised to see that not a single turn of wire is short-circuited by defective insulation, as this will cause the transformer to heat up unduly, and perhaps burn out. The wires of an alternating current lighting circuit of 110 volts should be connected directly to (P, P′), and if these directions have been followed, an alternating current of twenty volts pressure may be taken from (S, S′). The size of the core permits this secondary current to be anything from a fraction of an ampere up to about 20 amperes, thus adapting the transformer to running small motors, and lighting a number of small lamps in multiple or series-multiple. The current in the primary varies in direct proportion to that in the secondary; thus, a five ampere current in the secondary will require almost one ampere in the primary at 110 volts, while 20 amperes in the secondary will require nearly four amperes in primary. Thus the cost of secondary current is proportional to the amount used.

The core type transformer operates on the same principle as the ring wound type and is similar in construction, the chief dif-

ference being that its core is built up of sheets of soft iron, instead of wire. More tools and skill are required in its construction than in that of the ring wound, but it takes a great deal less time.

To make the core for this type of transformer, have the hardware man cut for you a pile of pieces of the very thinnest soft iron

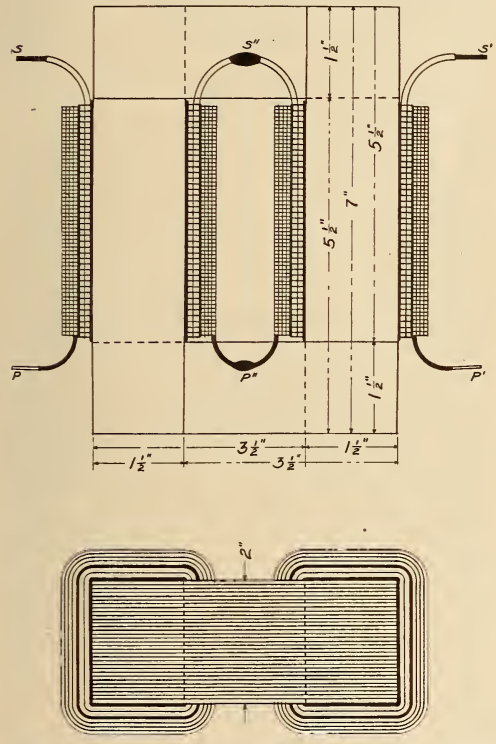


FIG. 3. STEPS IN CONSTRUCTION OF A CORE TYPE TRANSFORMER

sheet four inches high, 1½ inches wide and 3½ inches long, and another pile four inches high, 1½ inches wide and 5½ inches long. Then pile up the 5½ inch pieces in two bundles seven inches long and two inches high, by laying one sheet on another so it projects 1½ inches beyond it on one end, then the next sheet 1½ inches beyond that on the other end, and so on, until the bundle, when completed, will resemble a piece of wood with dove-tailed joints. When the bundles are made up, clamp them in a vise and wrap tightly with tape within 1½ inches from each end.

Fifty turns of heavy wire are wound on each bundle for the secondary, and 275 turns of lighter wire for the primary, making this winding the same as for the ring wound.

The two bundles are now placed side by side and the 3½ inch pieces for the yokes are slipped in the dove-tail ends, completing the transformer, as shown in Fig. 3.

Care should be taken in connecting the two primaries and the two secondaries together to see that the current will travel in the same direction around the core on each side.

Referring to Fig. 3, when (P, P′) are supplied with 110 volts, the voltage between (S) and (S′) is 20, and between (S) or (S′) and (S″) is ten. At the same time the primary winding may be used as an auto-transformer, and 55 volts taken from between (P) or (P′) and (P″).

To make the primary winding in either transformer for use on 220 volts, wind with 1100 turns of No. 23 B. & S. magnet wire, the secondary remaining the same.

How to Make a Direct Current Ammeter

Many amateurs would like to make their own instruments, partly on account of the cost of such instruments when purchased outright and partly for the love of construct-

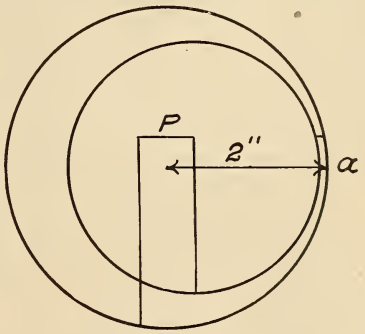


FIG. 1

ing, which gives one the shortest road to full understanding of the instrument. The ammeter described herein does not require any special tools or materials. When carefully made it is quite accurate for small direct current measurements.

To begin the instrument secure a good piece of soft sheet iron, commonly called stove-pipe iron. Set a pair of compasses at two inches and draw a true circle as shown in Fig. 1. Then draw another smaller circle with the center point about one-fourth of an inch to the right and about the same distance above the first center. The width at

(a) must be about one-fourth of an inch and will gradually taper to the heel. After drawing the other lines at (P), cut out with a pair of tin shears and the shape will then be as shown in Fig 2. at (N). Using this for a pattern cut out enough pieces to make a compact mass one-fourth of an inch thick.

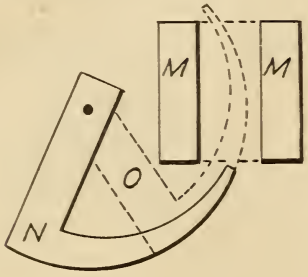


FIG. 2

These should be all clamped together in a vice and the outer edges all smoothed up at the same time until they are perfectly even and then with a soldering iron and acid carefully sweat the whole outside, making one solid mass. Next bore a one-eighth hole in the top of the shank for a little supporting shaft. Care should be exercised to get the hole at right angles to the surface.

Next secure a piece of steel wire that will make a snug fit in the hole just drilled. Cut it off one and a half inches long and bring the end to a perfect V point. This will require some pains and if the first time you do not succeed try again. As soon as a perfect point has been made it should be tempered glass-hard and smoothed up with very fine emery paper, placed through the hole in (P) and soldered there.

Next secure an old alarm clock. The balance wheel in these clocks runs in pivot bearings and as this balance wheel sets in the center of one of the brass side strips of the frame they are just what we want, as these strips will be $2\frac{1}{4}$ inches long and about three-eighths of an inch wide. These should be cut out and if it so happens that there are no holes in the extreme ends for screws they should now be drilled. Secure a good piece of wood for the back board and with small screws secure one of the strips to it as shown at (K) Fig. 3. Make a block of wood, well seasoned, as shown at (A) and this will want to be about $1\frac{3}{4}$ inches thick and should be thoroughly dry and well shellacked to prevent it ever absorbing moisture and warping. The scale block shown at (E) and (G) should be five inches long and of sufficient width to allow the cardboard scale to be glued to it, and about two inches thick. The pointer is cut out of thin sheet brass or copper and should be soldered to (D) and bent to the shape shown in the side view so as to come up over the scale block. This is done so that the scale will be near the glass when the instrument is boxed. The pointer can be made jet black by covering it with India ink and allowing it to dry slowly.

The coil (B) comes next and the size of the wire will be determined by the number of amperes that you wish the instrument to register. We will say that this one will be called upon at times to register 30 amperes. Therefore it must be wound with not less than No. 8, B. and S. gauge insulated wire. This coil is wound on a hollow iron cylinder, $1\frac{1}{8}$ inches in diameter, and the coil should not be over $1\frac{3}{4}$ inches long. It should be wound carefully and evenly and it would be well to try say 25 turns. The coil should be carefully taped and placed in position and securely held there with the small brass strip running through it as shown by (R). Its position on the board is such that the curved part of the movable member will be drawn up into the hole in the coil as shown more clearly at (M), Fig. 2. This action takes place when current is sent through the coil (B) and is on the principle of the solenoid.

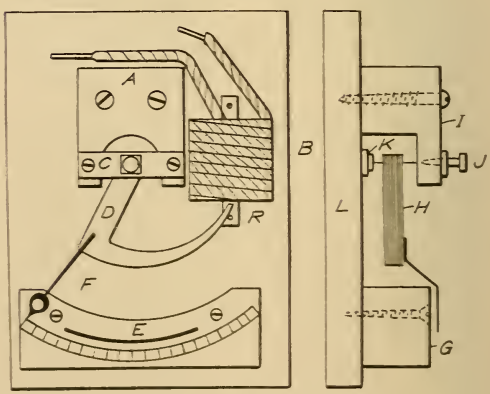


FIG. 3

It is supposed that the amateur to calibrate this instrument has the use of a standard instrument. If such is the case they both should be connected to the lighting circuit in series and with a water rheostat.

Slowly immerse the plates in the salt solution until the standard instrument has reached 30 amperes. Note where the pointer of this lies on the scale. If you have too many turns in (B) it will be over to the right too far, probably off the scale altogether. If there are not enough turns it will swing to the right but a short distance. If the latter is the case more turns of wire should be added, if the former, take off a few turns.

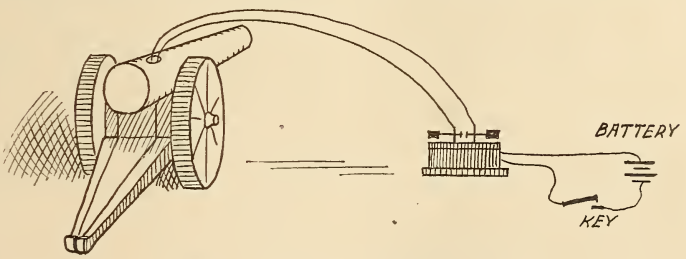
When the extreme limit of the scale is reached on 30 amperes, mark the point with a lead pencil. Then by means of the water rheostat vary the current so as to ascertain the 5, 10, 15, 20, and 25 ampere points on the scale. Mark these also. Finally, mark these five ampere spaces up into five equal divisions each, so that the scale will show one ampere divisions.

We are now ready to box the instrument which is a simple job. Provide a glass to go over the scale. Two heavy binding posts should be secured and the terminals of (B) should be carried one to each post. The instrument is now ready for use and will be accurate in proportion to the workmanship of the builder.

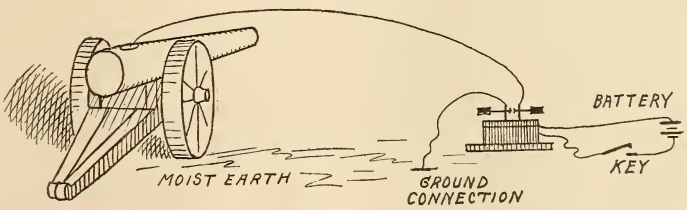
These instruments have their drawbacks as they must be used in a vertical position, the same as all gravity instruments, which can always be told by the pointer resting on zero when no current is on. The instrument should not be used near the powerful fields of a dynamo as this is apt to cause the readings to be far from true.

A Sane Fourth of July Celebration

On July 4th and 5th a group of boys of about 14 to 16 years of age got together to celebrate. They were firm believers in the "sane" Fourth, which has been advocated so widely throughout the country, and although they wanted to make some noise, as usual, they were determined to do so in a manner to prevent scorched faces, torn thumbs and other common forms of mutilation too frequently attendant upon Independence Day celebrations.



FIRING CANNON BY SPARK COIL



IT ALSO WORKED WITH GROUNDED CONNECTIONS

One of the boys was a wireless enthusiast and owned a very good spark coil and this was determined upon as a means of firing a cannon owned by one of the other boys, and the diagram shows how they accomplished the trick.

First they connected two rubber covered wires to the two terminals of the spark gap of the coil and led these to the cannon, which was several feet away, the coil being out of the danger zone. The cannon was loaded and the two ends of the wires were inserted in the vent, but not quite touching. When the key of the spark coil was pressed down, sending current from the battery through the primary of the coil, the spark, instead of jumping the regular spark gap, jumped across between the two ends of the wires in the vent, igniting the powder.

The boys were also successful in shooting off the cannon, at a distance of 15 feet, with a ground circuit as shown in the second illustration. One terminal of the coil was grounded. The other terminal was connected to a wire leading into the powder in the vent, but not touching the metal of the cannon.

QUESTIONS AND ANSWERS

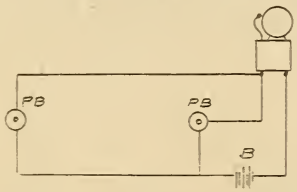
Readers of Popular Electricity are invited to make use of this department. State your questions as clearly and concisely as possible. No consideration will be given to communications which do not contain the full name and address of the writer

Bell Wiring; Double Pole Snap Switch; Keyless Socket

Questions.—(A) Please give diagram showing how to arrange a circuit to ring one bell from two push buttons some distance apart. (B) If a keyless socket has the lamp removed will the meter register any current? (C) When are double pole snap switches required on lighting circuits? (D) In wiring for annunciators should the main wire carrying the current from the battery to the various push buttons and annunciators be larger than the wires which run from the push buttons to the numbers on the annunciators? What size wire should be used?—J. W., Sudbury, Ont., Can.

Answers.—(A) See diagram.

(B) No. The center contact of the socket is of one polarity and the screw shell



BELL WIRING

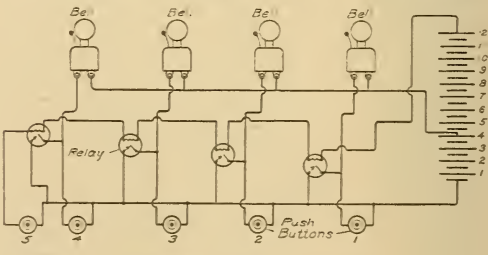
of the other. The circuit is complete only when the lamp is screwed in until its center contact strikes the socket's center contact.

(C) Chicago city rules say: "Switches must not be single-pole, except when the circuits which they control supply not more than six (6) sixteen (16) candle power lamps or their equivalent." Referring to double pole switches these rules under electric heaters say: "Switches must be double pole where the device controlled requires more than three hundred and thirty (330) watts of energy." In the National Electrical Code double pole snap switches are referred to under electric heaters as follows: "Switches must be double pole except where the device controlled does not require more than 660 watts of energy."

(D) For electric bells "annunciator wire" is much used. It is No. 16 B. and S. gauge copper wire insulated with two thick layers of cotton, wound in opposite directions, paraffined and varnished. By some, the extra cost of using rubber covered wire of the above number is so small that it is considered poor economy not to use it. The same size wire is used throughout.

Special Bell Circuit

In the answer to H. A. E. in the July issue a diagram was shown for the operation of four call bells at once by a fifth push button. While the system would work with the fifth push button as shown, all four bells would of course also ring upon pushing any of the other buttons unless switches (not shown in the diagram) were put in between the first four buttons on the upper common wire, to be opened on each side of the ringing button only when that particular button was to be used. Another way the first four buttons could be made to ring their bells independently, and at the same time ring the four bells with the fifth button, would be to use relays as shown at each of the stations. These relays are so arranged



SPECIAL BELL CIRCUIT

that upon pushing the fifth button the armatures will draw up and close the circuits to all four bells, but when the fifth button is not in use the bells may be operated singly by their individual buttons.

The diagram shows the relays connected in series. With this arrangement and low resistance relays, say 20 ohms in all, about 12 dry cells in series would be required for

the operation of the relays, about four being sufficient for the bells as shown. The relays might also be connected in parallel in which case six cells would be sufficient.

Figuring Size of Wire

In the answer to H. C., Sedalia, Mo., July issue, the formula for circular mils contains the factor L, or length of wire in feet. This means the total length of the two wires of the circuit and in applying the formula should be taken as twice the distance traversed by the line. In the example given, the length of the line is 7920 feet and L, the length of wire in feet, should have been taken as 15,840 feet instead of 7920 feet.

Changing Motor from 133 to 60 Cycles

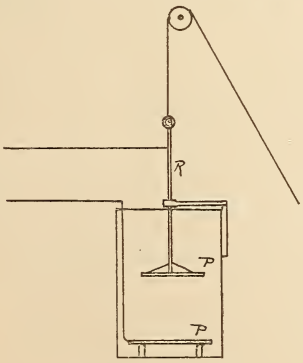
Question.—What is necessary to change an induction fan motor from 133 cycles to 60 cycles.—M. S. W., Linton, Ind.

Answer.—The iron cross section of the field for 60 cycles should be twice as great as for 133 cycles, a thing not easily complied with. The motor will run at only one-half its former speed. To make it run at its former speed it would be necessary to provide only one-half the present number of poles. Under this condition it would not be practicable to attempt to change the motor over.

To Make a Water Rheostat

Question.—Please give directions for making a 500-volt water rheostat.—J. L., Milford, Mass.

Answer.—The sketch shows in general a plan that may be used in making a water



WATER RHEOSTAT

rheostat. The vertical rod (R) may be adjusted by means of a pulley as shown. Use an ordinary barrel for your purpose. Provide circular iron plates (PP) 3-16 of an inch in thickness. At the bottom of the barrel place three or four porcelain knobs or three line glass insulators. Make connections as shown using stranded copper wire, rubber covered. Vary the resistance by adjusting the distance between the plates. By adding salt the current will be increased owing to the increased carrying capacity. Use clear water to start with. It is not usual to add more than two or three percent of salt. Salt is not good for accurate work, sulphuric acid being better, using very small quantities.

Transformer Connections

Question.—Referring to Fig. 3, page 56 of the May, 1909, issue, if the primary wires were delta connected and the secondary Y connected, what would be the voltage between phases?—A. H. M., Montreal, Canada.

Answer.—The primary leads as there shown are Y connected to the line and the secondary are delta. If, as you suggest, the primary wires are delta connected to the line, each of the three windings will receive 2,200 volts as in Fig. 1. Arranging the secondary as a Y connection, the secondary voltage will be $\frac{2200}{20} \times (\sqrt{3}$ or 1.73) giving 190.3 volts between phases.

Rating of Dry Cells

Question.—What is the voltage, current and internal resistance of the ordinary dry cell?—F. B. O., Chicago.

Answer.—No dry cell should be kept in stock longer than one year. The internal resistance of fresh dry cells varies from 0.1 to 0.7 ohm, and the E. M. F. from 1.3 to 1.6 volts. Dry cells of the ordinary size should not be used where a current of over 0.15 ampere is required.

Specifically, the following rating is given the cells named:

	E. M. F. Volts	Internal Resistance, ohms.
Leclanche	1.48	.3 to .5
Smee	1. to .59	.1
Nungesser (1900 Dry Battery)	1.6	.1

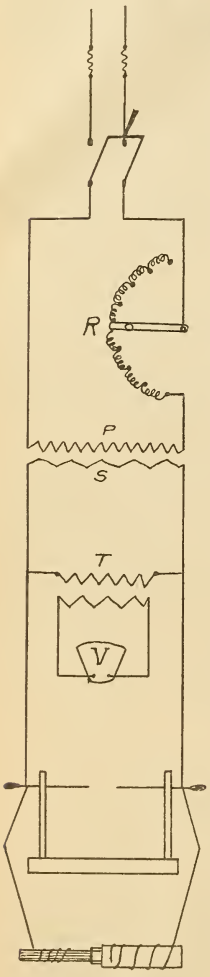
Reading a Meter

Question.—Please give directions for reading a electric light meter.—P. McD., Jefferson, Iowa.

Answer.—See article on "Measuring Electric Current" in the June, 1909, issue.

Puncture Test for Insulation

Question.—Will you explain the puncture test so that same may be applied to any high insulating material.—A. R. H., Portland, Ore.



PUNCTURE TEST

Answer. — The diagram shows how connections may be made to make a test. An alternating current generator or service wires may be connected to the primary of a step-up transformer, a rheostat (R) being placed in series with one side. From tests for high voltages we know that the following pressures will spark across needle points in air as shown in the figure:

Volts	Spark Gap in Inches
10,000	.47
20,000	1.0
30,000	1.62
40,000	2.45
50,000	3.55
100,000	9.6

In accordance with the above, the needle points are set so that a spark will jump across them when the voltage has been raised to the value at which it is desired to test the insulation. A voltmeter (V) may also be connected to a transformer (T) and its readings multiplied by the ratio of the transformer in order to check the accuracy of the needle setting and the high voltage.

Samson Cell

Questions.—(A) Please tell me what is necessary to recharge a Samson wet battery. (B) Is it necessary to short circuit this battery for 24 hours after recharging?—G. A. B., Spencer, Mass.

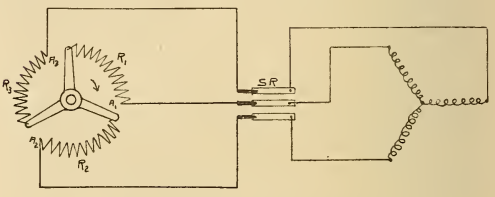
Answers.—(A) Four ounces of sal ammoniac in water enough to fill the glass jar outside the porous cup is sufficient, the jar being 4½ inches in diameter and 6 inches high. Boil the carbon for one hour in water.

(B) No.

Induction Motor Speed Regulation; Mercury Rectifier

Questions.—(A) Kindly give diagram of the ordinary induction motor showing method of speed regulation. (B) Explain the mercury arc rectifier. —C. T., Kansas City, Mo.

Answers.—(A) An induction motor tries to run in synchronism with the alternator except as losses due to friction, etc., check it.



INDUCTION MOTOR DIAGRAM

The diagram shows a Y-wound armature, with the three terminals connected to slip rings (S. R.). With the resistance arms in the position shown each winding has in series with it a resistance. When the resistances are thus placed in the armature circuit the slip must be large in order to make sufficient current flow to provide the necessary torque. Hence when these resistances are in, the speed of the motor is low. In crane work this method is common. With the arms resting on points (A_1), (A_2) and (A_3) all resistance will be out of the armature and the full voltage will be impressed on the windings. Each arm is connected to the main line.

(B) See answer to S. N. in June, 1909, issue.

Single Phase Motor

Question.—How would you reverse the direction of rotation of a single phase, four pole, alternating current motor?—J. S. C., Keokuk, Iowa.

Answer.—An induction motor with only a single winding on the field, instead of two or more sets of windings differing in phase, connected to single-phase mains will not start of its own accord. If given a start it will come up to speed in whichever direction it is set going provided no load is applied. Single phase motors, however, are often provided with two or three-phase windings for starting, and the pressure displaced or split in phase by introducing resistances and inductance in the circuit of these special windings. After the motor comes up to speed these resistances and inductances with their windings are cut out. Reference to some standard treatise on induction motors will give you further information.

Motor on 110 Volts; Connecting Batteries; Three-way Switches

Questions.—(A) Please explain how to connect a 6-volt motor in series with 16 candle power lamps on a 110-volt circuit. (B) Which is the best for running motors, four batteries in series and three series in parallel, or twelve batteries in series? (C) Give diagram for connecting two three-way switches. —R. Y. N., Tilton, N. H.

Answers.—(A) Place in one side of the circuit to the motor two standard 52-volt lamps. This will give six volts across motor terminals.

(B) It depends upon the voltage and current required by the motor. Knowing this, and also the voltage and current available from one cell of your battery arrange the connections according to the following rule. Connect in series the number of cells necessary to give the pressure required by the motor, that is, the voltage of one cell multiplied by the number of cells in series gives the voltage across the line to the motor. If more current strength is required place more series sets in parallel across the motor supply mains.

(C) See answer to W. W. H. in the February, 1909, issue.

Soldering Fluid Formula; Lead and Zinc

Questions.—(A) Will you give a formula for making a soldering fluid? (B) What is the difference between lead and zinc? (C) Will lead mix with copper in the form of an alloy?—J. A. H., Chicago, Ill.

Answers.—(A) The following formula for soldering fluid is suggested by the National Board of Fire Underwriters in the National Electrical Code:

Saturated solution of zinc chloride	5 parts
Alcohol	4 parts
Glycerine	1 part

Soldering fluid containing acid is not recommended because of the effect on the insulation of wires. For bare wire work, however, this may be made as follows: Take two ounces of muriatic acid; add zinc till bubbles cease to rise; add one-half teaspoonful of sal ammoniac and two ounces of water.

(B) Zinc is a common metal found in the form of ore combined with sulphide and carbonate. Belgium and the Rhenish provinces produce more than one-half of the world's supply, and the Belgian process is commonly used to separate it from the ore. Zinc blend or "black jack" (ZnS) and the carbonate ($ZnCO_2$) are its important ores. Commercial zinc always contains some lead and iron, and traces of sulphur, arsenic, and cadmium. With lead, zinc readily combines when the two metals are melted together, but on cooling the zinc forms an upper layer while the lead forms at the bottom. German silver consists of copper, zinc, and nickel in the form of an alloy. All brass is now made by melting together copper and zinc.

(C) Yes, bronzes or brasses which are harder than the pure metal being the result.

Vacuum Sweepers; Dry Batteries; Ground Connection

Questions.—(A) In a vacuum sweeper how is the dust kept from going into the suction part? (B) Can an old dry battery be recharged by passing a 110-volt direct current through it. (C) Can the ground wire for a wireless apparatus be connected to the gas pipe in the operator's house? My friend and I are not able to communicate, using this method. Do you think that is the trouble?—H. E. S., Detroit, Mich.

Answers.—(A) Explaining briefly one make of sweeper, a centrifugal suction fan is operated in a chamber by a motor, direct connected, the latter being outside the fan pocket. The mouth of the suction-portion running over the floor has a few inches inside, a wire sieve or screen which stops the coarser dirt, a drawer being provided into which it drops. The finer dust passes on through the fan and is blown into a cylinder or dust chamber. This chamber has a sort of cheese cloth arranged so as to form three concentric bags, the dust-ladened air being forced into the first, through this, then through the walls of the second bag and finally through the third cheese cloth wall. The air by this time has been cleaned or strained and comes out through many fine perforations in the walls of the metal cylinder. The cheese cloth sacks are so arranged as to be made of a single piece of cloth. In removing the dirt the cylinder is taken off the pipe leading to it and the top removed. The cheese cloth sacks are then removed and cleaned.

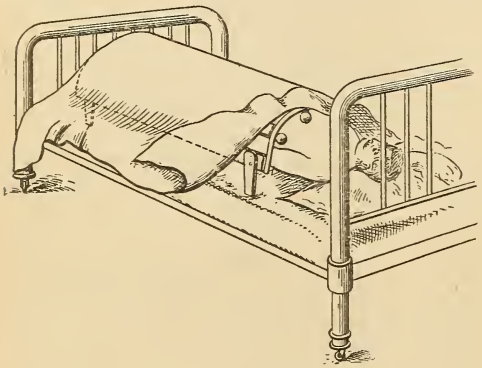
(B) No.

(C) Gas pipe is a good ground though not a safe one, unless the ground wire is connected on the street side of the meter. Your trouble must be elsewhere than in this ground. Water piping is considered the best ground.

NEW ELECTRICAL INVENTIONS

Electric Light Bath

The efficacy of strong light upon the body in the treatment of certain diseases is well known, its value being largely in the germicidal effect of the rays and the stimulation derived from the heat and radiant energy. Sunbaths we all know to be healthful, and



ELECTRIC LIGHT BATH

artificial light from electric lamps is used with almost the same results.

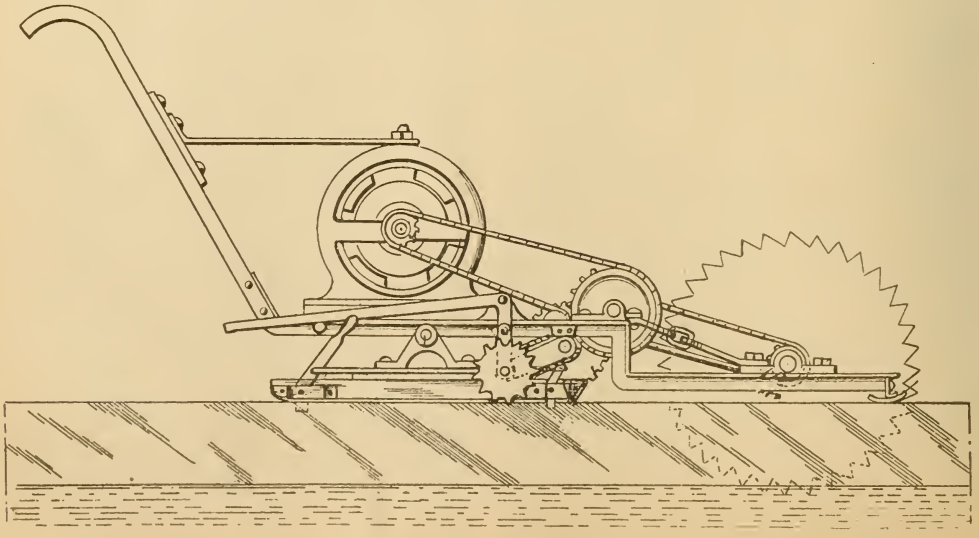
A new application of the electric light bath is shown in the cut and is the invention of Emmons Collins of Chicago, Ill. It consists of a half cylinder with interior reflecting surface studded with incandescent lamps. It is placed over the patient when lying in bed, the light being both radiated and reflected to the body, and at the same ime permitting massage treatment without the disarrangement of the apparatus.

Ice Cutting Machine

The unusual idea of applying electricity to the cutting of ice is embodied in a patent recently issued to Luna M. Macy of Adel, Ia. The diagram of this invention is self-explanatory. A motor is mounted on a sort of sled and by a system of chain and sprocket gears drives a toothed wheel for propelling the machine forward and a saw for cutting through the ice as it proceeds.

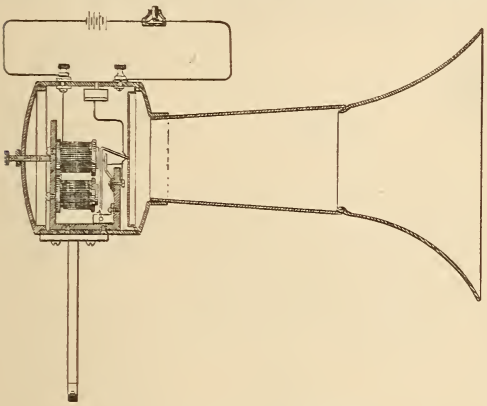
Electric Auto Horn

The diagram shows an electric automobile horn which is operated by the regular storage battery carried on the car for ignition purposes. On electric vehicles it is operated by the battery which drives the car.



ICE CUTTING MACHINE

In the base of the horn are two small electromagnets similar in principle to those of an ordinary buzzer or electric bell. An armature is mounted in front of the poles of the magnets and has a projecting member which moves the diaphragm of the horn back and forth. When current is switched into the electromagnet coils it energizes the pole pieces and causes them to give the



ELECTRIC AUTO HORN

armature a strong pull. This draws the armature up toward the pole pieces but in doing so the circuit to the electromagnet is broken, causing the pole pieces to become de-energized and to let go of the armature. The latter then flies back and closes the circuit repeating the operation. This occurs many times per second as long as the switch to the battery is closed, and causes the diaphragm to be vibrated back and forth with the armature, creating a loud sound in the horn.

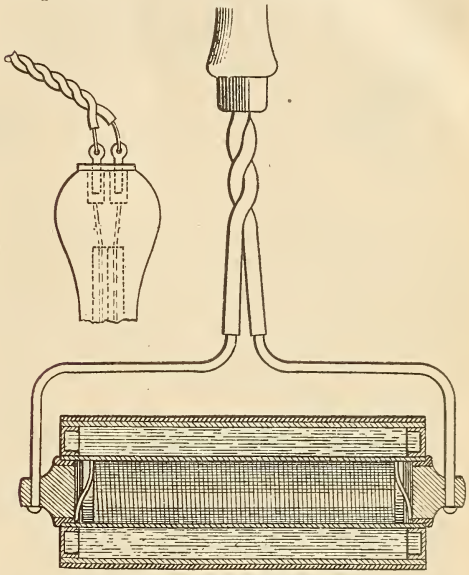
The apparatus is the invention of C. H. O'Brien of Augusta, Me.

Incubator Alarm

This invention relates to a thermostatic alarm. Inside the incubator is a thermostat which expands and contracts with the rise and fall of the temperature. This is connected by means of a system of levers to a circuit opening and closing device connected with an electric bell and battery. So sensitive is the device that should the temperature rise above or fall below that which must be maintained for the hatching of the eggs the bell circuit will be closed and the signal given. Perry S. Martin of Broadway, Va., is the inventor.

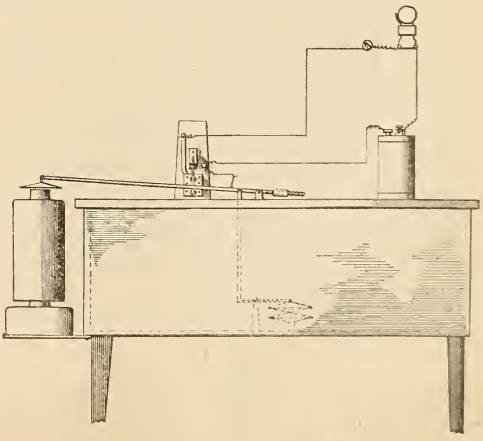
Electric Massage Device

A massage device, which embodies an electric heating element, is the invention of Nellie L. Coon of Rochester, N. Y. It consists of a massage roller with suitable handle. The roller is hollow, containing an outer compartment for water and an inner com-

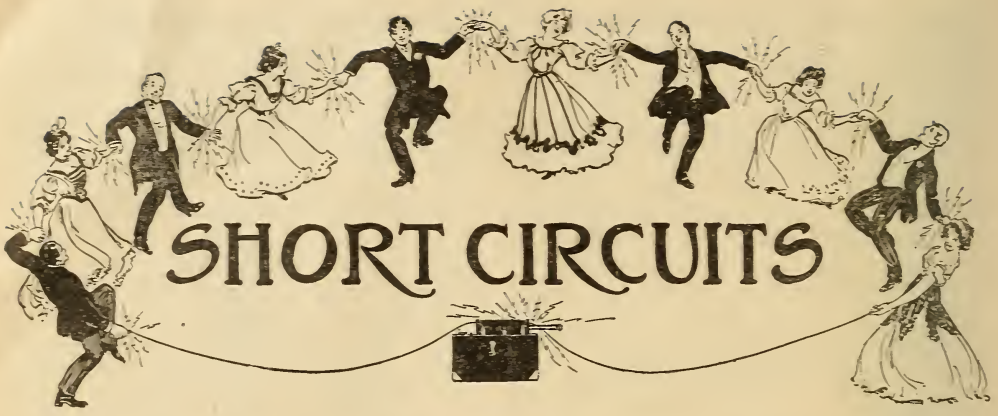


ELECTRIC MASSAGE DEVICE

partment for the electric heating element. When current is turned into the latter it is heated by the passage of electricity through a coil of very fine wire, and this heat is imparted to the water in the outer casing. The wires from the electrical source may then be disconnected and the water retains the heat for a considerable length of time.



INCUBATOR ALARM



SHORT CIRCUITS

The Shakespeare Club of New Orleans used to give amateur theatrical performances that were distinguished for the local prominence of the actors. Once a social celebrity, with a gorgeous costume, as one of the Lords in Waiting, had only four words to say: "The queen has swooned." As he stepped forward, his friends applauded vociferously. Bowing his thanks, he faced the king and said, in a very high-pitched voice, "The swoon has queened."

There was a roar of laughter; but he waited patiently, and made another attempt:

"The sween has cooned."

Again the walls trembled and the stage manager said, in a voice which could be heard all over the house, "Come off, you doggoned fool."

But the ambitious amateur refused to surrender, and in a rasping falsetto, as he was assisted off the stage, he screamed: "The coon has sweened."

* * *

A young girl once asked Mark Twain if he liked books for Christmas gifts. "Well, that depends," drawled the great humorist. "If a book has a leather cover, it is really valuable as a razor strop. If it is a brief, concise work, such as the French write, it is useful to put under the short leg of a wabbly table. An old-fashioned book with a clasp can't be beat as a missile to hurl at a dog; and a large book, like a geography, is as good as a piece of tin to nail over a broken pane of glass."

* * *

A Baltimore bank having a draft for collection on a firm in Florida, sent the draft forward for collection, and in reply received the following letter:

Dear Sir:—I wish to call your attention to the fact that I am no longer located at —— street, this city, and through force of circumstances, hard times, bad business, I am no longer the "Big Noise" of the firm whose name appears on this letterhead.

The firm whose officers, board of directors, office force and sales department consisted of the writer, has folded its lily-white hands across its virgin breast and turned up its pink toes to the daisies, and is solemnly studying botany, examining the dandelion's root and tender feelers of the forget-me-nots.

The firm name of —— is now of the past; no longer will its blithesome fog-horn voice be heard in the busy slaughter house of trade, and no more will the guileless jeweler be the mark of our rapacity and list price, with 60 per cent added.

We have entered the service of the —— Company, in which we are the "Slender Noise," but still able to be heard.

* * *

"Sawyer! Sawyer!" bawled the brakeman.

"Don't care if you did, smarty," said the young swain who had just kissed his girl. "We are going to be married next month anyhow, so it's nobody's business but our own."

"Now, children," commanded the austere instructor in advanced arithmetic, "you will recite in unison the table of values."

Thereupon the pupils repeated in chorus:

"Ten mills make a trust;
"Ten trusts make a combine:
"Ten combines make a merger;
"Ten mergers make a magnate;
"One magnate makes the money."

* * *

Dolly was out for a walk and met an old friend of her father.

"And how old are you, little one?" asked the old gentleman.

But Dolly was indignant.

"I'm hardly old at all; I'm nearly new," she answered, tossing her head.

* * *

An old negro had gone to a postoffice in Mississippi and offered for the mail a letter that was over the weight specified for a single stamp. "This is too heavy," said the postmaster. "You will have to put another stamp on it."

The old darkey's eyes widened in astonishment. "Will anudder stamp make it any lighter, boss?" he asked.

* * *

J. J. McGraw, the baseball expert, denied, at a banquet in New York, the marvels attributed to the spit ball.

"It's a good ball," he said. It fools the best of them. But when I hear some of the miracles put to its credit—well, then I think of Harriet Hare, of 'Frisco.

"I once read in a 'Frisco paper: 'Harriet Hare, of Nob Hill, got a needle in her waist two years ago, and only last week this needle worked its way out of the arm of a young Los Angeles rose farmer.'"

* * *

The lecturer warmed up.

"Let us follow civilization's torch," he cried. Before he could say more a little man in the back part of the hall suddenly bobbed into view.

"What is civilization's torch?" he shrilly demanded.

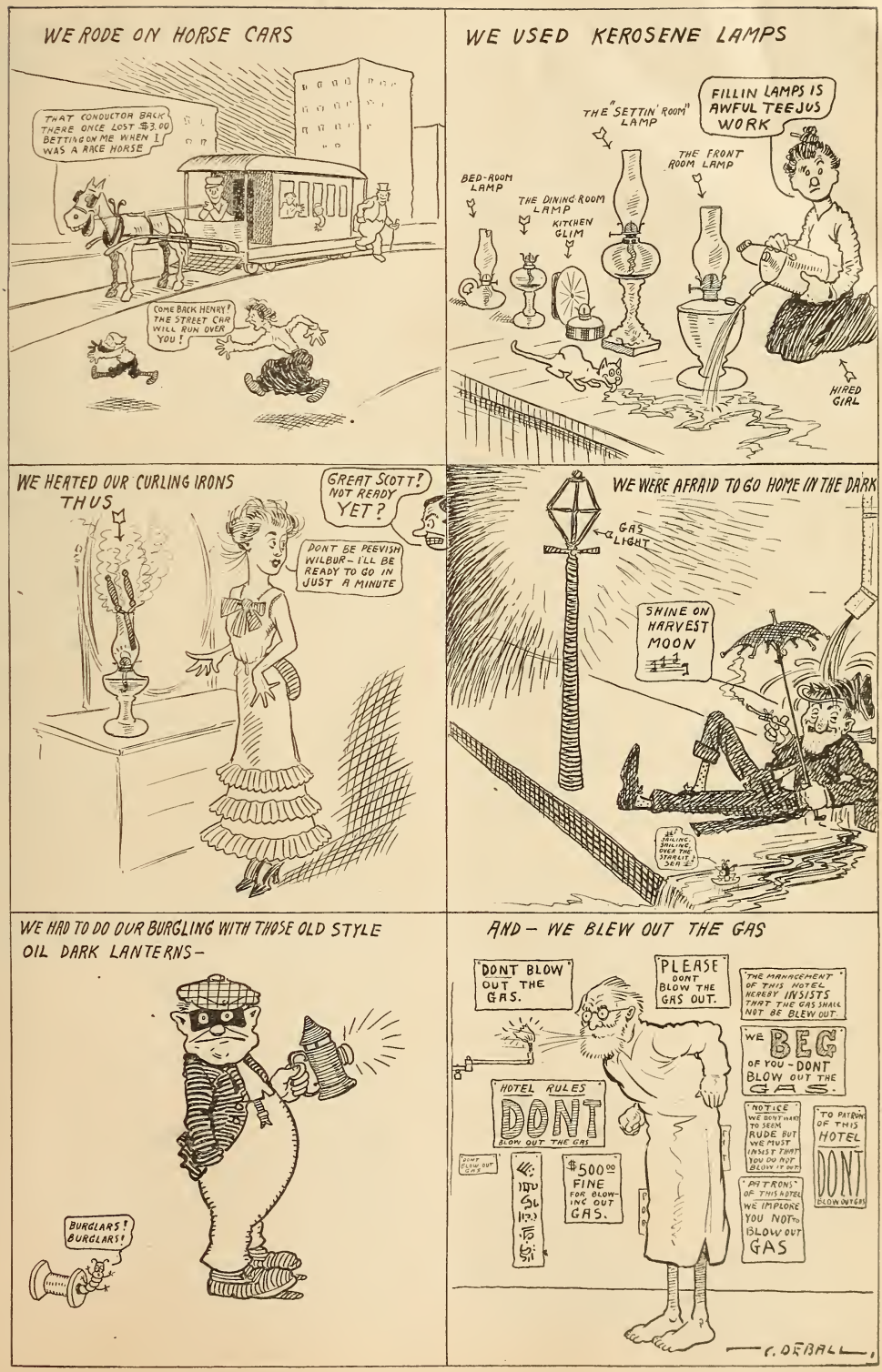
The lecturer was annoyed.

"Why, it's a-a-a—it's an expression."

"It ain't got nothin' to do with Standard Ile, has it?"

"No," the lecturer shouted back.

"Then you can go ahead with your lecture," said the little man as he disappeared from view.


WE RODE ON HORSE CARS
THAT CONDUCTOR BACK THERE ONCE LOST $3.00 BETTING ON ME WHEN I WAS A RACE HORSE
COME BACK HENRY! THE STREET CAR WILL RUN OVER YOU!
WE USED KEROSENE LAMPS
FILLIN LAMPS IS AWFUL TEEJUS WORK
THE "SETTIN' ROOM" LAMP
THE FRONT ROOM LAMP
BED-ROOM LAMP
THE DINING ROOM LAMP
KITCHEN GLIM
HIRED GIRL
WE HEATED OUR CURLING IRONS THUS
GREAT SCOTT! NOT READY YET?
DONT BE PEEVISH WILBUR- I'LL BE READY TO GO IN JUST A MINUTE
WE WERE AFRAID TO GO HOME IN THE DARK
GAS LIGHT
SHINE ON HARVEST MOON
WE HAD TO DO OUR BURGLING WITH THOSE OLD STYLE OIL DARK LANTERNS-
BURGLARS! BURGLARS!
AND - WE BLEW OUT THE GAS
DONT BLOW OUT THE GAS.
PLEASE DONT BLOW THE GAS OUT.
THE MANAGEMENT OF THIS HOTEL HEREBY INSISTS THAT THE GAS SHALL NOT BE BLEW OUT.
WE BEG OF YOU - DONT BLOW OUT THE GAS.
HOTEL RULES
DONT
BLOW OUT THE GAS
$500.00 FINE FOR BLOWING OUT GAS.
NOTICE WE DONT WISH TO SEEM RUDE BUT WE MUST INSIST THAT YOU DO NOT BLOW IT OUT
TO PATRONS OF THIS HOTEL
DONT
BLOW OUT GAS
PATRONS OF THIS HOTEL WE IMPLORE YOU NOT TO BLOW OUT GAS
R. O'FALL

WHAT DID WE EVER DO WITHOUT ELECTRICITY?

ELECTRICAL DEFINITIONS

Below are defined a few of the most common electrical terms. They are reprinted from month to month and will be of assistance in understanding the magazine text

Accumulator.—See secondary battery.

Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.

Ammeter.—An instrument for measuring electric current.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt. The international ampere is the current which, under specified conditions, will deposit .001118 gram of silver per second when passed through a solution of nitrate of silver in water.

Ampere Hour.—Quantity of electricity passed by a current of one ampere flowing for one hour.

Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.

Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.

Brush.—The collector on a dynamo or motor which slides over the commutator or collector rings.

Bus Bars.—The heavy copper bars to which dynamo leads are connected and to which the outgoing lines, measuring instruments, etc., are connected.

Buzzer.—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.

Candle Power.—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.

Capacity, Electric.—Relative ability of a conductor or system to retain an electric charge.

Charge.—The quantity of electricity present on the surface of a body or conductor.

Choking Coil.—Coil of high self-inductance which retards the flow of alternating current. See self-inductance.

Circuit.—Conducting path for electric current.

Circuit-breaker.—Apparatus for automatically opening a circuit.

Collector Rings.—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.

Commutator.—A device on a dynamo shaft for gathering the current from the various coils of the armature and sending it out over the line as direct current. On a motor it takes current from the line and passes it on to the armature coils.

Condenser.—Apparatus for storing up electrostatic charges.

Cut-out.—Appliance for removing any apparatus from a circuit.

Cycle.—Full period of alternation of an alternating current circuit.

Dielectric.—A non-conductor.

Dimmer.—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.

Direct Current.—Current flowing continuously in one direction.

Dry Battery.—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.

Electrode.—Terminal of an open electric circuit.

Electromotive Force.—Potential difference causing current to flow.

Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.

Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.

Farad.—Unit of electric capacity.

Feeder.—A copper lead from a central station to some center of distribution.

Field of Force.—The space in the neighborhood of an attracting or repelling mass such as a magnet or a wire carrying current.

Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.

Generator.—A dynamo.

Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.

Insulator.—Any substance impervious to the passage of electricity.

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

Leyden Jar.—Form of static condenser which will store up static electricity.

Lightning Arrester.—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.

Motor-dynamo.—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa, or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.

Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.

Neutral Wire.—Central wire in a three-wire distribution system.

Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in height.

Parallel Circuits.—Two or more conductors starting at a common point and ending at another common point.

Polarization.—The depriving of a voltaic cell of its proper electromotive force

Potential.—Voltage.

Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.

Rheostat.—Resistance device for regulating the strength of current.

Rotary Converter.—Machine for changing high-potential current to low potential or vice versa.

Secondary Battery.—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.

Self-inductance.—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.

Series.—Arranged in succession, as opposed to parallel or multiple arrangement.

Series Motor.—Motor whose field windings are in series with the armature.

Shunt.—A by-path in a circuit which is in parallel with the main circuit.

Shunt Motor.—Motor whose field windings are in parallel or shunt with the armature.

Solenoid.—An electrical conductor wound in a spiral and forming a tube.

Spark-gap.—Open space between the two electrodes of a spark coil or resonator.

Storage Battery.—See secondary Battery

Thermostat.—Instrument which, when heated, closes an electric circuit.

Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

Volt.—Unit of electromotive force or potential. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

Volt Meter.—Instrument for measuring voltage.

Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.

Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.

CLASSIFIED ADVERTISING

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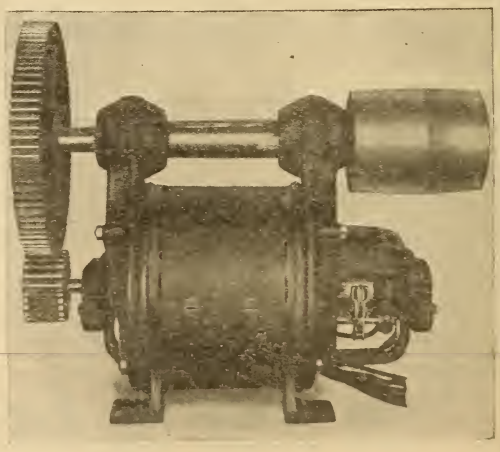

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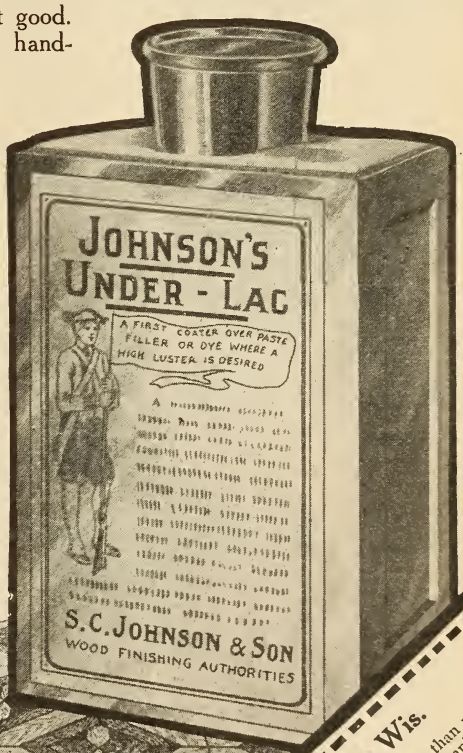
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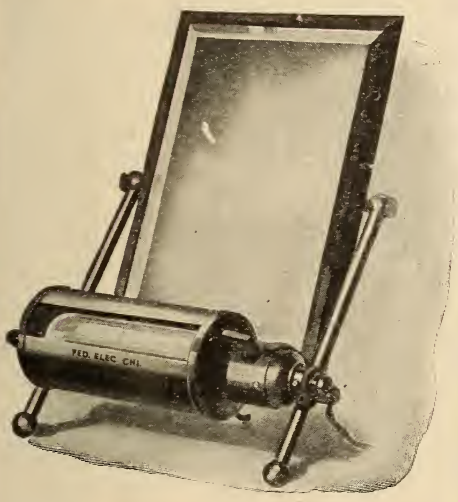

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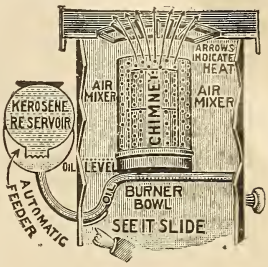

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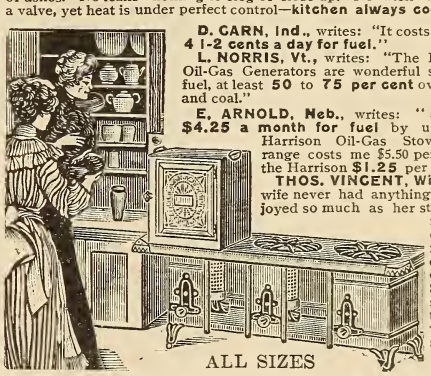

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Ideal for roasting, cooking, baking, ironing, canning fruit, picnics, cottages, camping. **In winter** use Radiator for heating houses, stores, rooms, etc. No more carrying coal, kindling, ashes, soot and dirt. **No hot fiery kitchens.** Absolutely safe from explosion. Not dangerous like gasoline. Simple, durable—lasts for years. Saves expense, drudgery and fuel bills.

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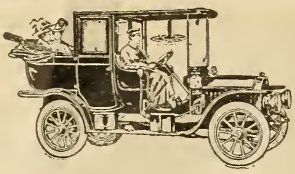

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DYKE'S COURSE is the only course in the world which can successfully be taught by mail. We use wonderfully clever **Working models** (made in Europe) of the **Gasoline Engine** and **Magneto** and **Carburettor** that actually work and they picture the meaning while you study our interesting Instruction Pamphlets.

JUST IMAGINE, having in your room an **engine cut in half** and with each and every part lettered and numbered, also a Carburettor and Magneto lying on your study table while you study our interesting course—that's practically what we give you in our **working models.** You will play with these models like a boy with a toy and the more you play the clearer the subject will be to you.

IN ADDITION we give 24 lessons which are so interesting you will finish them all—they are illustrated with 34 large clear charts.

WE TEACH YOU everything there is to learn about the Automobile and Gasoline Engine such as valve setting, timing ignition, how the cylinders fire, construction of all forms of Magnetos and how to set them, storage batteries and all systems of wiring, and many other important subjects.

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"I've learned more in three weeks study of your Course than during my ten years work around the shop."

Another customer who knew nothing about the Auto or Gasoline Engine says he can now run any car and set valves, etc.

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AUTOMOBILE OWNERS will save the cost the first month.

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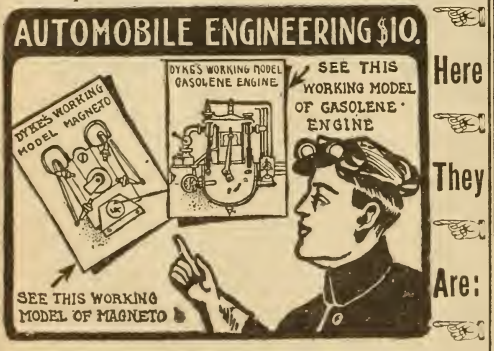
NO MATTER how much you would pay you could not possibly get a course equal to this one.



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I have customers, not a few, but many, who have smoked my Panatelas continuously for seven years, or since their introduction.

That seems to prove that my Panatela "wears well," that it is not too heavy or strong for continuous smoking; that the tobacco is not drugged or doctored; that the quality is uniform year in and year out.

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My way of selling cigars gives my customers cigars at wholesale prices—about half what equal quality costs in retail cigar stores. Incidentally, it is chiefly because my customers are continually sending in repeat orders of their own accord, that I am able to give and continue giving the cigar values that I do. These repeat orders cost me nothing and keep down selling costs—and selling costs are a big item in the cigar business, when done in the usual way.

MY OFFER IS:—I will, upon request, send fifty Shivers' Panatela Cigars on approval to a reader of Popular Electricity, express prepaid. He may smoke ten cigars and return the remaining forty at my expense if he is not pleased with them; if he is pleased, and keeps them, he agrees to remit the price, $2.50, within ten days.

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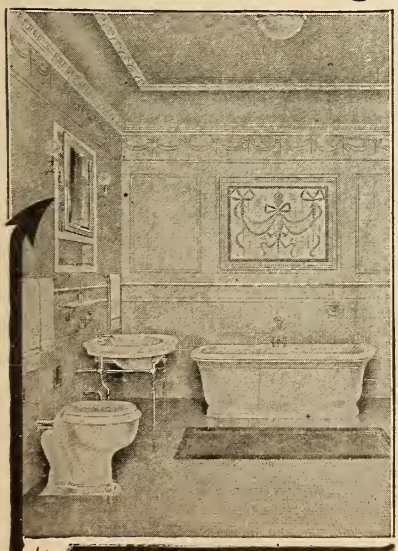

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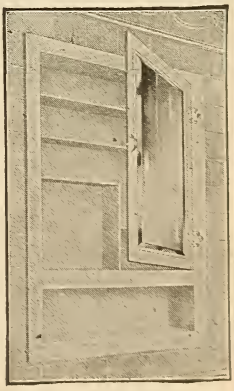

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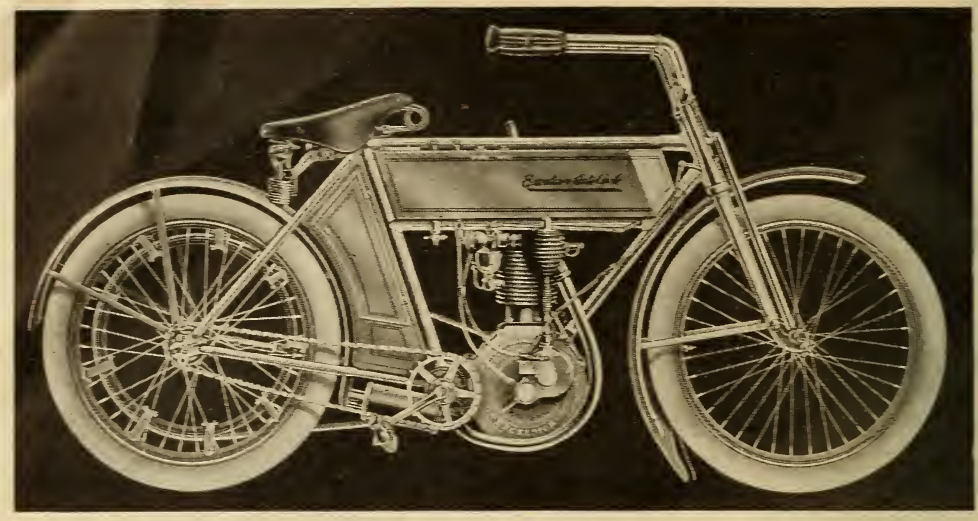

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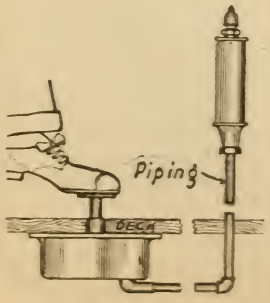

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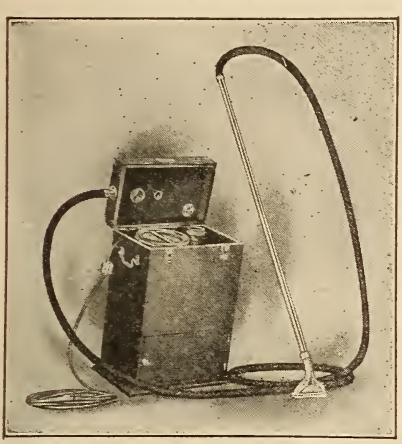

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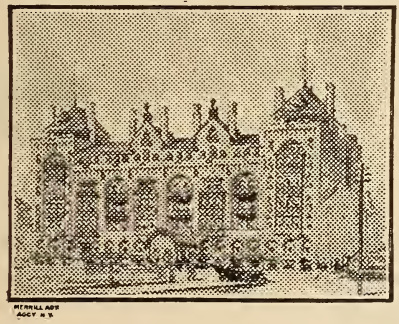

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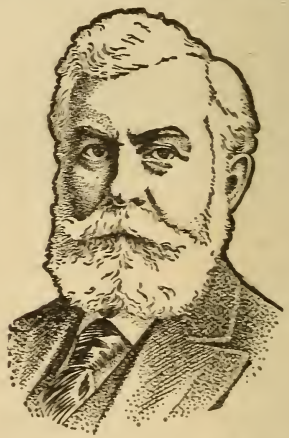

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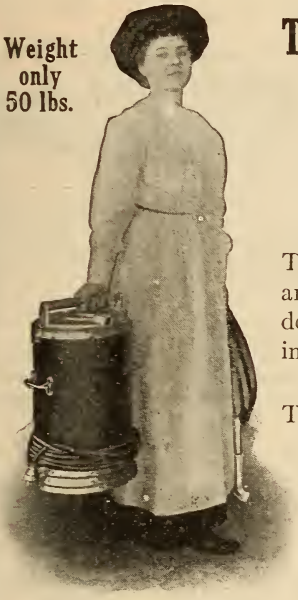

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Like all articles of superior merit the Santo has its imitators. The Santo is the **original** round, portable cleaner. It can not be approached in efficiency, durability or completeness, by any other cleaner at any price.

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Instead of the verbal promises given with most cleaners and which are seldom worth anything, we give you a guaranty bond bearing our corporate seal and signature.

We agree and guarantee to replace without cost to you any parts proving defective in material or workmanship at any time, whether it be in one year, five years, or longer.

This guaranty means something. It insures you against loss and protects you in your right to use the Santo.

The Santo has been perfected after an experience of over 15 years and at an experimental cost of over $50,000. It is perfect—the final in vacuum cleaners, you can not buy more in a portable vacuum cleaner, even at five times the price.

Our cleaner is built as perfectly and of as fine material as the most expensive automobile. No tin, paper mache or other flimsy material enters into its construction. No wood except the hardwood top handle.

As a result of our experience we have determined the efficiency absolutely necessary to do perfect cleaning. Our standard as embodied in the Santo is as follows:

It will produce a maximum vacuum of 7 to 8 inches Mercury standard.

It has a calculated displacement of 25 to 30 cubic feet free air per minute.

It may be operated continuously without stalling or overheating.

It does not require special heavy fuses, and will not endanger your wiring.

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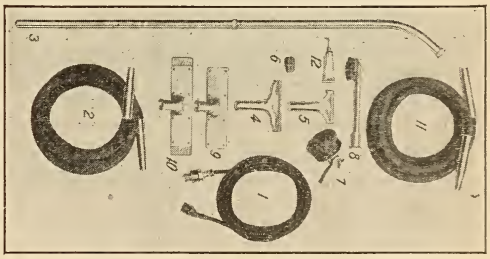
Any electric cleaner having LESS efficiency than the Santo will utterly fail to meet your requirements.

The highest grade polished aluminum equipment ever furnished with a vacuum cleaner—nothing more to buy.



1—Electric cable for connecting cleaner to lamp socket.
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7—Wall brush, for walls, ceilings, mouldings, etc.
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10—12-inch nozzle, felt-faced, for sweeping floors.
11—Mercerized braid-covered blowing hose for drying hair, airing bedding, etc.
12—Tube of lubricant which eliminates greasy oil can.

The Santo cleans everything without removal. It makes your home spotlessly clean and dustless.

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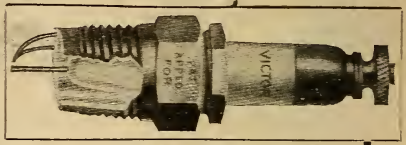

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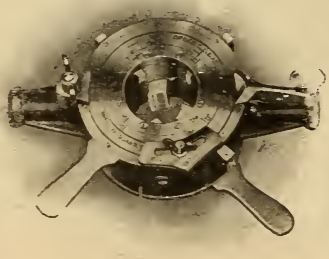

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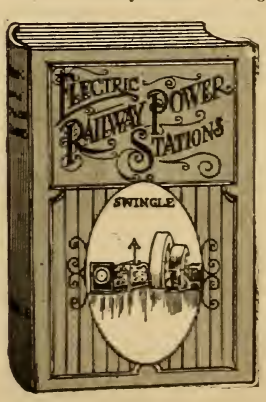

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do a volume of business **greater** than that of **any other store or combination of stores on earth**—none excepted. We have furnished nearly 2,000,000 homes—have been in business **54 years** and stand today pre-eminent in our line—the **oldest, largest and best known** home furnishing concern on the American Continent. Capital and surplus larger than that of any other similar institution in the world.

PRICES POSITIVELY UNMATCHABLE

We can **save you** from 20% to 40% on any article you may need in your home. We can **cut under the prices** of any other firm in the business. You can't afford to place an order with **any** other concern on earth, until you have received our Big Catalogues—**simply can't afford to.**

This Solid Oak Rocker 4.75=

Is strongly constructed and beautifully finished, solid oak frame, hand carved, also massive carved heads, full spring seat and tufted back, upholstered in Nantucket leather which has the wearing quality of genuine leather. **TERMS—75c cash and 50c monthly.**

CATALOG FREE

Our new fall **Furniture Catalogue** is the largest and handsomest book of the kind ever published. It is an immense volume, just filled with **unmatchable bargains** in everything to furnish and beautify the home, including furniture, carpets, rugs, draperies, crockery, sewing machines, clocks, silverware, and pianos, a portion of the goods being beautifully illustrated in colors. Our special **Stove Catalogue** is also an immense volume of world-beater bargains—positively the biggest values ever offered. Write for these two big catalogues at once—**write for them today.**

SATISFACTION OR YOUR MONEY BACK

Our guarantee of satisfaction is **not limited to 30 days,** but is given for an indefinite period. We refund money and freight charges on all purchases not entirely satisfactory. Our policies are broad, liberal and generous.

Cut out this coupon and mail it to us today.

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223-225-227 and 229 Wabash Ave., Chicago, U. S. A.

☞ State whether you wish Catalogue of Furniture, Catalogue of Stoves, or Catalogue of *Furniture and Stoves.*

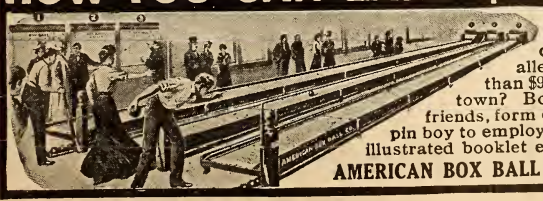
Please mail me Big Free Catalogue of .....

Name .....

P. O. Address 19

HARTMAN FURNITURE AND CARPET CO., CHICAGO, U. S. A.

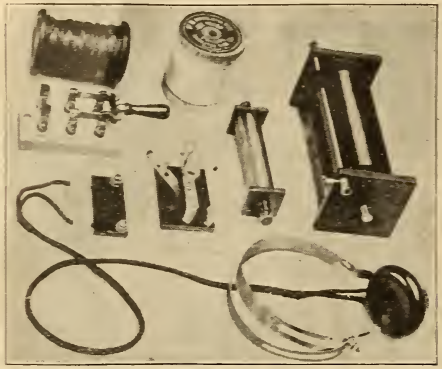
HOW YOU CAN EARN $300 OR MORE A MONTH



One box ball alley costing $150, took in $513 the first fifty-one days at Sullivan, Indiana. Two other alleys costing $365, took in $1,372.95 in five months. Four large alleys costing $840, took in $1,845.20 in fifty-nine days, more than $900 a month. Why not start in this business in your own town? Both men and women go wild with enthusiasm; bring their friends, form clubs and play for hours. Players set pins with lever—no pin boy to employ. Alleys can be set up or taken down quickly. Write for illustrated booklet explaining **EASY PAYMENT PLAN.** Send for it today.

AMERICAN BOX BALL CO., 1902 Van Buren Street, Indianapolis, Indiana

WIRELESS APPARATUS



This is the surprise we promised you. Our "Tri-mount Junior Receiving Set" (Type A) consists of the following:—

Single Slide Tuning Coil	$2.50
Micanite Fixed Condenser. .003 mfd	1.50
3 Adjustment Detector Stand	1.00
1000 Ohm Telephone, with 3 foot cord. Split Headband and 3 Phone Block	4.25
Double Pole Double Throw Switch	.65
450 ft. Stranded Antenna Wire	1.25
1 lb. Annunciator Wire	.35
Mounted on Baseboard. complete	.50
Cost. if bought separately	$12.00
OUR PRICE (delivered)	**10.00**

Every article in above set will be found to embody "Tri-mount Quality." It is a very efficient set and is sure to give satisfaction. Send for prices on anything you may require. See our advertisements in previous numbers.

The Tri-Mount Wireless Supply Co.
R. A. CHANDLER, Manager
13B Irving Street BOSTON, MASS.

GUDEMAN & COMPANY

Artistic Electrical Decorations

114-118 East 23rd Street, • • NEW YORK, N. Y.

Electrically Lighted

FRUIT TREES

FERN DISHES

FLOWER BASKETS

FLORAL FESTOONS

and many other designs.

Miniature and Decorative Lamps
Christmas Tree Outfits

Our goods are on sale at
ELECTRIC SHOP
Michigan and Jackson Blvd., Chicago, Ill.

Write for descriptive catalogue

THE STEINER ☐ MOTOR ☐

A HOUSEHOLD NECESSITY

The Steiner Family Motor Outfit is the greatest Household labor-saving device ever invented since Electricity has become generally used.

It does all the hard work that is tiring to the Housewife—invaluable on wash days—does all the hard work when preparing meals—a man-of-all-work during house-cleaning time. It will polish your silver, run your sewing machine, make Ice Cream, grind your coffee, chop your meat, etc., etc.

Anything around the house that is hard work for you. The Steiner family motor will do it and in 1-2 the time.

The above illustration is outfit No. 3 containing 1 Motor, 1 High-Grade Ball Bearing Wringer, 1 Clear White Washer, 1 Sewing Machine Attachment, 1 Polisher and Grinder, 1 Grater, 1 Ice Cream Freezer, 1 Meat Cutter, 1 Coffee Mill. ALL BEST GOODS OBTAINABLE, sold at a price that is within the reach of all.

Sent on 30 days free trial. Outfits No. 1 and 2 include the same Family Motor only there are not so many appliances.

Write for folder and price.

Over 1000 in Use

Agents can make big money selling Steiner family motor outfits.

Central Stations and Electrical Supply Houses write immediately for our proposition.

Steiner Mfg. Co., St. Louis, Mo.
2605 N. 14th STREET

Thordarson's

Junior Bell-Ringer

Eliminates All Battery Trouble

Price $3.00

Suitable for residence door bells, buzzers, and all classes of light signal work.

Consumes no current. Will last a lifetime.

Approved by Board of Underwriters

Thordarson Electric Mfg. Co.

151-157 So. Jefferson St. CHICAGO, ILL.

ALCOHOLISM

EARL'S ANTÔL has established a most remarkably successful record in the treatment of the Liquor Habit. It is simple and convenient to take, it is pleasantly exhilarating in operation, it is most effective in results, and

THE COST IS A MERE TRIFLE

The Antol Treatment will not hamper you with inconvenient or embarrassing conditions, for you can carry these tiny capsules in your vest pocket and take them—**while attending to your ordinary business**—without consulting anyone or attracting the attention of inquisitive people.

I am so **absolutely certain** of the successful outcome of the Antol Treatment that I fearlessly

GUARANTEE

the return of your money in full, without question or comment, should you not be thoroughly satisfied with the result. I have also guaranteed—under the "Food and Drugs Act"—that Antol does not contain any Drug injurious to health, so just as soon as you have made up your mind

TO QUIT DRINKING

write for my **Free Booklet** on the Curious Manifestations produced by Light, Medium, and heavy Drinking; study therein your own particular symptoms, **and send for a bottle of Antol.**

Clip this notice out, for future reference, but **write now** for my Free Booklet. Address, **JOHN C. EARL,**
Antol Laboratories, 660 Gates Avenue, Montclair, N. J., U. S. A.

Flaming Arc

Intense Light

Made by a Warner Flaming Arc attracts attention at a distance or close by.

¶ Admitted by all to be the strongest light yet produced.

¶ Lamp practically indestructible, and made of fireproof material.

¶ Made for multiple use on A. C. or D. C. and for Series on High Tension D. C. Series.

¶ Vertical Carbon 5-8x12. Only one to trim.

¶ First cost less, maintenance less, and service greater than any other lamp made.

Warner Arc Lamp Co.

Muncie, Ind. **Wilton, Iowa**

FILL IN AND MAIL
Warner Arc Lamp Co.,
Muncie, Ind. Wilton, Iowa
Mail us catalog of your Flaming Arc

Name

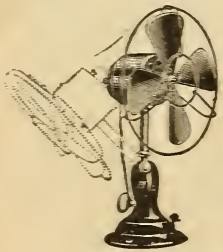
Address

We Sell Anything Electrical

The largest Electrical Mail Order House in the Country. We sell you your Electrical Supplies **by Mail at Bargain Prices.**

Anything for the **Household, Office, Store, Factory,** also the Student and Experimenter. Large stock always on hand. Deliveries prompt.

Some of Our Specialties for September



Eclipse Socket Fans for Home Use

This is the most convenient Fan for the Office and Home. Can be turned at any angle, the stand remaining permanent—finished in brass—is an ornament to any home. Hardly any noticible difference on your **Electric Light Bill.** Keep the room Cool and Sanitary, price so reasonable that every home should be equipped with one.

Stand has Swivel Motion; can be set to throw air at any angle, or used as a Bracket Fan. **Price,** 104 Volts, 60 Cycle..... $13.00
104 " 133 " 14.00

Direct Current Socket Fan

Combination Stand also furnished with this Fan at
$2.00 Extra
110 Volts, complete.. $10.00

8-inch Blade Socket Fan Motor

can be screwed into any ordinary lamp socket without any additional plug or socket.

The body of the Motor is made of aluminum and the trimmings are nickel finish. Total weight is 1¾ pounds. The price within reason of all. Ought to be in every home and office.

Prices 104 Volts, 60 Cycle $11.00
104 " 133 " 12.00

The Pacific Easy Chair LAMP

is without doubt the best Electric Portable ever manufactured. This Lamp is as portable as a candle-stick and may be placed wherever light is desired, irrespective of whether there is a table or a stand at hand or not. The light may be easily raised or lowered and an adjustable shade and a hinged joint at the socket, permit of perfect adjustment of the light for any class of work. By the use of this Portable, the light may be so arranged as to fall on the reading matter or work only, thereby shading and resting the eyes.

Price..... $5.00

Regarding this Lamp, Mr. W. E. Russell, president and treasurer of the Massillon Light, Heat and Power Co. of Massillon, Ohio, writes as follows:

"The No. 50 Easy Chair Lamp ordered for the writer's personal use arrived in due time, and is not only a fine fixture, but a GREAT SAVER TO POCKET AS WELL AS EYES. Please send me three (3) more."

The Ever-Ready Dry Battery

This battery is beyond doubt the most efficient for Wireless Telephone or Telegraph work—does twice the work of other battries and lasts longer. Its square shape makes it most convenient for all kinds of work where the cells are exposed.

Electrical Experimenters should use the Ever-Ready.

Ask us for our special price in quantities.

Price per cell.....30c each

We Are the Manufacturers of the Famous American Vibrator

Note—Let us quote you on everything Electrical. Send for our Free Catalogue.

SOUTHERN ILLINOIS ELECTRIC CO., St. Louis, Mo.

IN ALL THE WORLD
NO TRADES PAY MORE THAN
THOSE OF THE
ELECTRICIAN
PLUMBER AND BRICKLAYER
These are the trades that we teach by practical and individual instruction under actual working conditions and enable you in two to three months to accept a position paying $5 a day and over. Tools take the place of books; we have no classes; it depends entirely upon yourself. We can teach you the Plumbing, Bricklaying, or Electrical trades, and assist you to a position upon graduation. Write to-day for free catalogue and information.
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Electricity

VOLTAMP

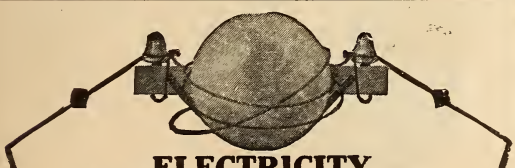
is the most wonderful and interesting scientific study of the age. Every boy, girl and grown-up should know about it. Our fascinating 112 page book just out makes it easy for you to learn.

We'll send you this new, enlarged catalogue on receipt of 6c. It contains a coupon which entitles you to a rebate of your 6c on first order of 50c or over.

Catalogue contains hundreds of Illustrations and descriptions of Voltamp electrical products—Wireless Instruments, Motors, Dynamos, Machine Models, Toys, Telegraph Instruments, Batteries, Meters, Coils, Switches, Geissler Tubes, Lamps, Flash-Lights, Telephones, Bells, Miniature Railways, etc.

A boon to the experimenter as well as the practical electrician.

Voltamp Electric Mfg. Co.,
Baltimore, Md.



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Practically and Individually
TAUGHT

Our pupils actually handle the tools and machinery.—Instructors stand beside them, directing, criticising and showing them how to work. —Day and Evening sessions.—Call and inspect our school and equipment or write for prospectus.

New York Electrical School
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$45.00 MONTHLY PAYMENTS $45.00

YOUR CREDIT IS GOOD

with us. Any honest person can buy a diamond here, or any other article of jewelry from our complete stock, and pay for it on easy payments to suit one's convenience—one fifth down and the balance in eight monthly installments is about as preferable a way as any. No red tape inquisitive systems are used—it is a plain business proposition, based on dealings with honest people.

Our integrity and reliabilty is unquestioned; we refer you to all commercial agencies and express companies in the United States. Our numerous buying facilities give you the benefit of low prices—one-third is easily saved by dealing with us. Buy a diamond for yourself, your father, mother, sister, brother or sweetheart. It is an ideal gift, remembered by the one so dear to you after all other presents are long forgotten.

The ladies' and gents' elegant rings shown here are extra specials, reduced to $45.00, so as to give everybody a chance to buy advantageously. The diamond is a beauty—exceptionally white, guaranteed pure, perfect and flawless.

Send your name and address, with size of ring desired, and we will send you same by express prepaid. If perfectly satisfied, and we know you will be so, pay the express agent $9.00; the balance you yay in eight easy monthly installments of $4.50 each. These rings you see right here are worth, at any retail store, from $60.00 to $75.00

Our line of high grade watches, silver ware, etc. is complete. Our handsome illustrated catalog with many more money saving prices and exquisite descriptions of exquisite jewelry is free for the asking. Write right away.

WM. E. RENICH CO.
Diamonds, Watches, Jewelrr
124-130 State St. Chicago, Ill.

For our Mutual Advantage mention Popular Electricity when writing to Advertisers.

Six Months to Pay For Good Clothes

$12.95

For this Splendid All-Wool Suit—made in the latest style. Your choice of cloth.

$3.35 Cash

$1.60 Monthly

This Suit will be sent on approval.

Dress in Clever Style

Our free Fall Style Book shows photographic plates of the swellest suits and overcoats for fall and winter wear. We want to send it to you.

With it we send samples of all-wool clothes in thirty desirable patterns. We buy nothing but all-wool cloth. Every yard is guaranteed.

We also send a tape line with simple instructions for taking your measure. We will fit you perfectly, as we have thousands of others.

This book quotes prices on high-grade clothes which are astounding. You never saw clothes like these sold so low. You have probably paid at least $18 for such suits as we sell for $12.95. The reason lies in our enormous output.

Any suit or overcoat, made in any cloth we show, will be sent you on approval. We guarantee the workmanship, the price and the fit. If not entirely satisfactory, send the garments back, and all your first payment will be returned.

We sell on six months' credit, without any security and without any interest. Our credit prices are exactly the same as for cash. You can pay a little down and a little each month, and dress just as well as the best dressed man you know.

We ask a chance to please you once, and secure your permanent trade. Please send this coupon—send it today—for our free Fall Style Book and samples.

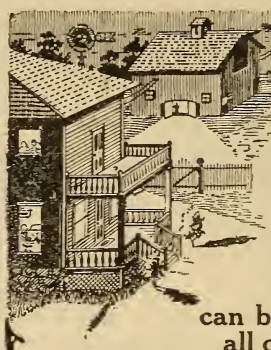
THE CLEMENT CO.
385 Franklin St., Chicago

Mail me your Style Book—free

Name _____

Address _____

_____



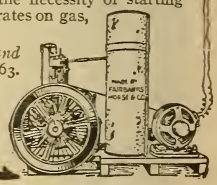
Perfect Light and Plenty of Water

can be piped or wired all over your place

A Fairbanks-Morse Electric-Light Outfit

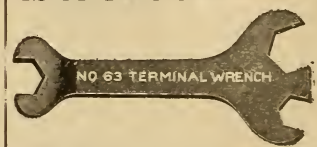
Will give you all the light, water and power you need for your farm, country place or store at a surprisingly low cost. Engine can be left running for hours after starting without attention, and stopped by pressing a button. The safest, most convenient, and healthful light known. It is restful to the eyes and does not consume the life-giving oxygen in your rooms as the lamps or gas. Same engine runs pumps and other machinery. It is usually desirable to install also a storage battery, so that lights can be used at any hour, night or day, without the necessity of starting the engine each time. Engine operates on gas, gasoline, kerosene or distillate.

Cut out complete advertisement and send for special catalog No. C A 1163.



Fairbanks, Morse & Co.
Chicago, Ill.

KLEIN'S TERMINAL WRENCH IS A TROUBLEMAN'S FRIEND



This No. 63W Wrench is especially adapted for use on terminal nuts, receivers, transmitters, and binding posts, etc. There are three different side openings, with dimensions as follows: ⅜ inch, ½ inch, and 7-16 inch, which will engage either square or hexagonal nuts. One end is bent at an angle of 45 degrees, to allow its use in confined places. Total length, 2 13-16 inches. The cost is so small, and the convenience so great, that one of the wrenches should be in every Electrician's Tool Kit. Mailed to any address for **17c.** Have you one of our latest catalogues? Send 3c in stamps for a copy.

MATHIAS KLEIN & SONS, Station U. 3, Chicago. Ill.
Manufacturers and Jobbers of
Electrician's, Linemen's and Construction Tools

Wire, Coils and Cordage

NORWAY IRON WIRE for cores, COTTON, SILK and ENAMELED MAGNET WIRE, heavy and fine sizes for primary or secondary windings, receiver coils or coils of any kind.

COILS wound to your specifications.

BELL WIRE and ELECTRICAL CORDS for every purpose.

The above furnished at lowest prices in small quantities for wireless telegraph or experimental purposes, or in large quantities for manufacturers.

Write for prices to Dept. E.

BELDEN MANUFACTURING COMPANY
194 Michigan Street - - CHICAGO, ILL

Protect Your Tungsten Lamps With a

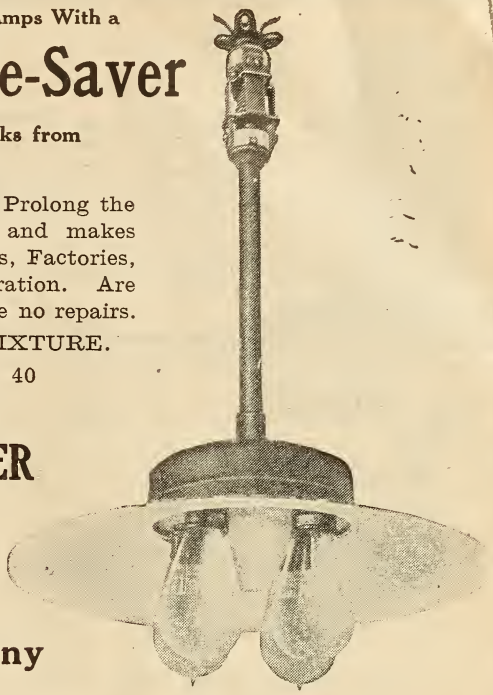
Tungsten Life-Saver

Prevents Injurious Shocks from Vibration

TUNGSTEN LIFE-SAVERS Prolong the Life of Tungsten Lamps, and makes possible their use in Shops, Factories, Etc., where there is vibration. Are easy to install and require no repairs.

FIT ANY STANDARD FIXTURE.

BULLETIN No. 40



TUNGSTEN SHOP CLUSTER

An inexpensive cluster made of steel, with plain black finish, equipped with an 18 inch steel, porcelain enameled shade and Tungsten Life-Saver.

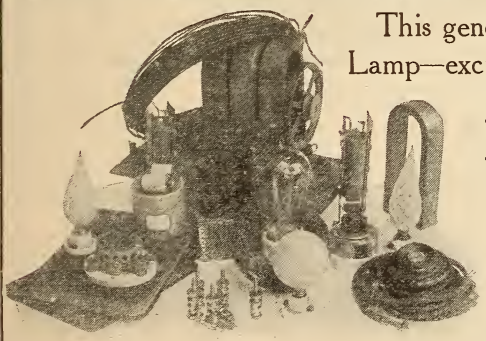
BULLETIN No. 42

American Arc Lamp Company

SPECIALTIES DEPARTMENT
Manufacturers

KALAMAZOO - - MICHIGAN

This Complete Electrical Experimental Outfit for $5.00



This generator (weight 6½ lbs.) will light a 16 C. P. Lamp—excite coils, test through 10,000 Ohms. Other Supply Houses ask Six Dollars for this Machine alone. Just the thing for testing department or experimental bench. Also

1—Laboratory Test Lamp and Socket.
1—200 page Compend of Electricity.
1—250 page Electrical Dictionary.
4 Pair—Electric Magnets (all different).
1—Solenoid Magnet (1¼ lb.).
1—Motor with Pulley.
1—Relay wound with silk wire 100 Ohms.
2—Miniature Incandescent Lamps.
2—Miniature Sockets for Lamps.
1—Box Swedish Iron Filings.
1—Permanent Magnet.
1—Electric Bell.
1—Coil Wire. 1—Switch.
1—Push Button.

SPECIAL—Genuine Swedish Iron Filings 25c per box prepaid.
Generators alone $3.

FREE—Cut this corner and send it to us with your remittance before Oct. 15th and we will send you in addition to the outfit a six-point Induction Coil, with platinum point vibrator, worth $2.00. PE-9

Western Electric Salvage Co.

597 So. Washtenaw Avenue, CHICAGO, ILL.

We Want To Tell You How

We Put Every Cent of the Dealers Profits into Your Pocket

You can **save** not only the dealer's profits but his excessive charges for installation and repairs by dealing direct with the manufacturers. You can keep in your own pocket at least one-third the retail price of a heating plant. Let us tell you all about the

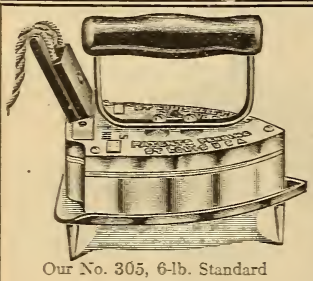
Jahant Down Draft Furnace

Only $10 down and $10 per month, with freight prepaid east of the Mississippi River. This wonderful furnace has proven its superiority above all others during the last ***30 years.*** It is without doubt the very best heating system for your home. It ***saves*** from ⅓ to ½ in fuel bills, because the patented "down-draft" burns hard or soft coal—wood or lignite—without cinders or clinkers, giving full heating value of every particle of fuel. Needs less attention than any furnace you ever saw. A strong "Guaranty Bond" goes with every Jahant, which allows you ***a 360 days free use of the furnace.*** You run no risk, as we supply special plans, full directions and give ***free all necessary tools,*** so that any man who can drive a nail can successfully install a Jahant.

No matter what make or system of heating you are considering, let us tell you more about the many conveniences and good points of our furnace: it's economy, it's healthfulness and how you can save money.

Write today for our book.

The Jahant Heating Co., 200 ***Mill St., Akron, Ohio.***



Our No. 305, 6-lb. Standard

When you have weighed out every detail after a searching canvass and have come to the final summing up—your decision—you will buy

PEACEMAKER ELECTRIC IRONS

EVERY POINT COVERED

They are built to meet this decisive moment, and win.

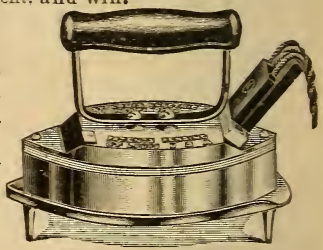
WE CAN SHOW YOU

A thirty days' trial will tell you all, save the life of the iron.

We have sold thousands of **Peacemaker Irons** which have been in continuous use—nine hours per day—more than two years, without the necessity of repairs, and are still in service.

We will ship you, charges prepaid, any **Peacemaker Iron** weighing under 8 lbs. for $4.00.

If you are not satisfied after 30 days, return the iron at our expense, and your money will be refunded or the charge cancelled.



Our No. 307, 6-lb. Double Pointed

ST. LOUIS ELECTRIC HEATING CO.

ST. LOUIS, MISSOURI

IMPLICITY PREFERRED

A "SANITARY" Water Supply System

"IT'S AUTOMATIC"

Water under pressure marks the greatest difference between the city residence and the country or suburban home. Our "Sanitary" Water System will furnish ample

WATER UNDER PRESSURE

for all purposes at a very small first cost and an extremely low cost of running.

They are operated by gas engine or electric motor. Catalogue free.

If your plumber can't supply you, write and give us your name.

THE SANITARY PUMP COMPANY

17 So. Canal St., Dayton, O.
42 Broadway, New York City, N. Y.
58 Dearborn St., Chicago, Ill.
507 Main St., St. Louis, Mo.

Will You Accept This Business Book if We Send it Free?

Sign and mail the coupon below. Send no money! Take no risk!

One hundred and twelve of the world's master business men have written ten books—2,070 pages—1,497 vital business secrets, ideas, methods. In them is the best of all that they know about

—Purchasing	—Salesmanship	—Position-Getting
—Credits	—Advertising	—Position-Holding
—Collections	—Correspondence	—Man-Handling
—Accounting	—Selling Plans	—Man-Training
—Cost-keeping	—Handling Customers	—Business Generalship
—Organization	—Office Systems	—Competition Fighting
—Retailing	—Short Cuts and	and hundreds and hundreds of other vital business subjects.
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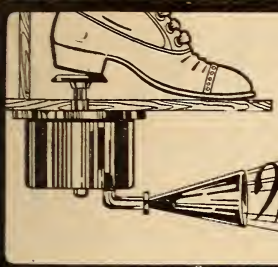
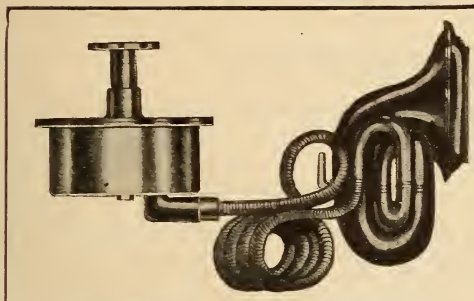
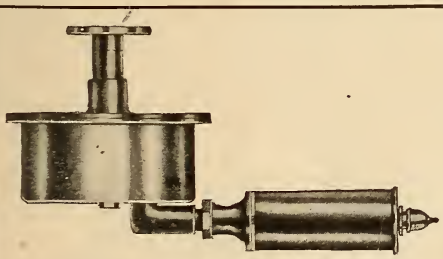


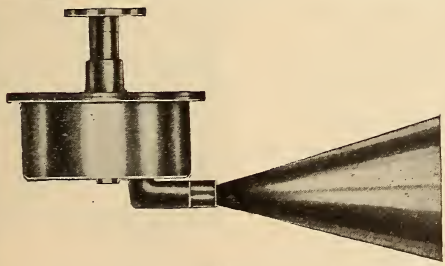
Wordingham Foot Horn



Use It with the Regulation Auto-Horn



Or Apply the Beautiful Two-Toned Whistle



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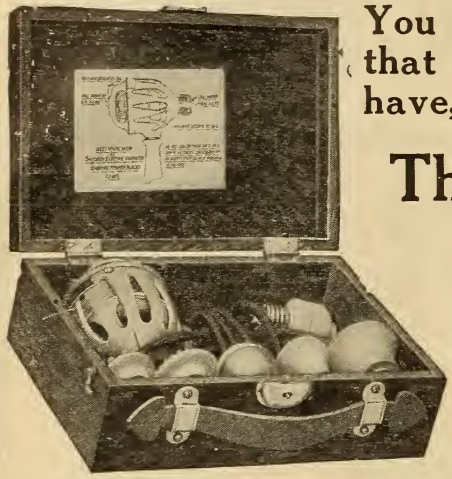

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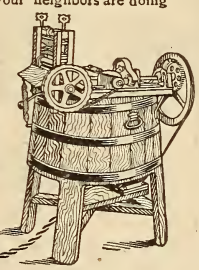

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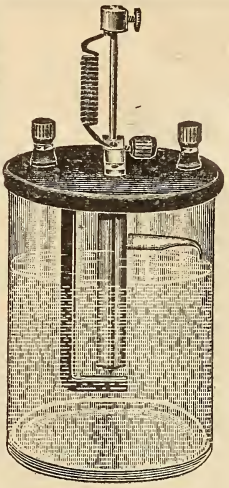

FIG. 2

FIG. 3

THE GERNSBACK ELECTROLYTIC INTERRUPTER

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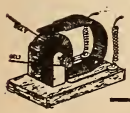

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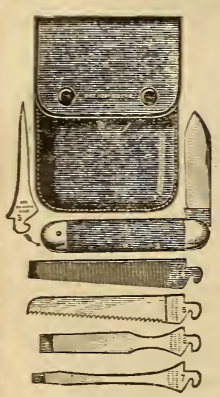

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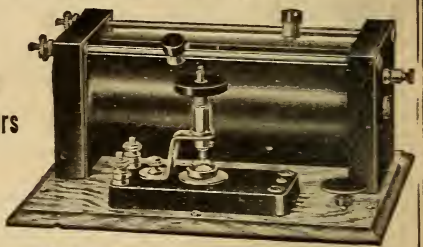

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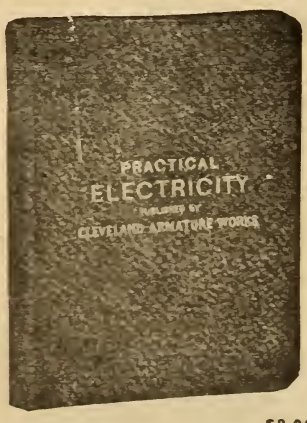

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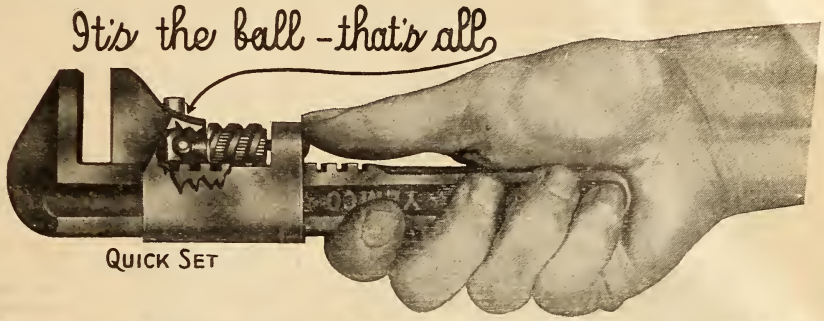

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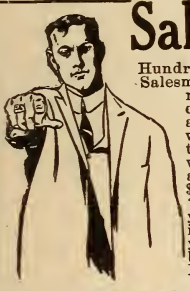

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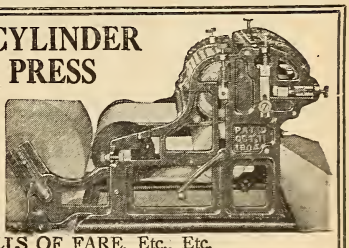

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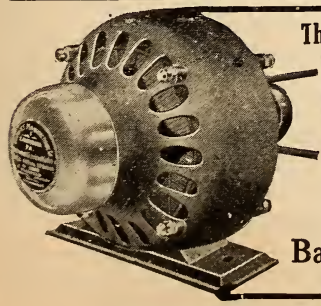

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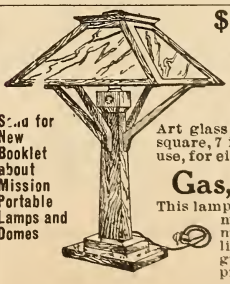

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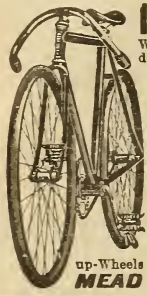

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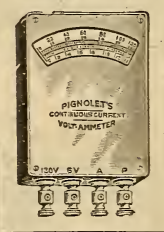

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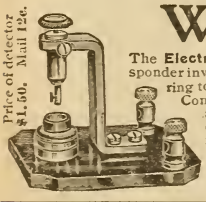

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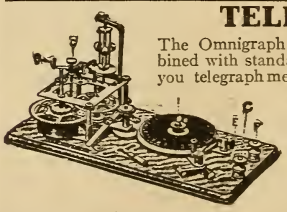

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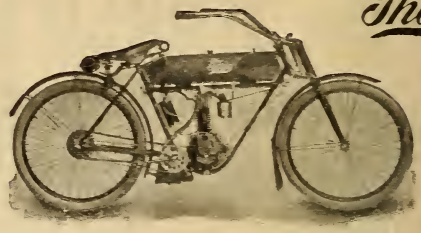

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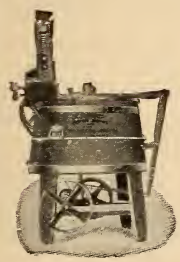

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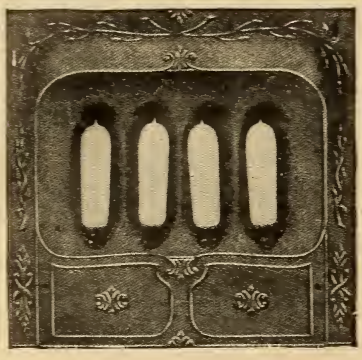

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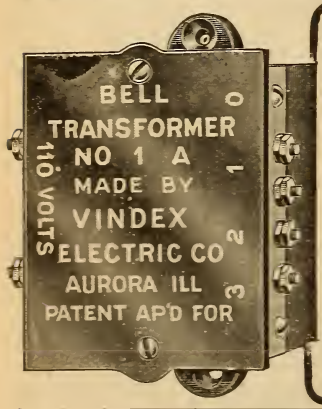

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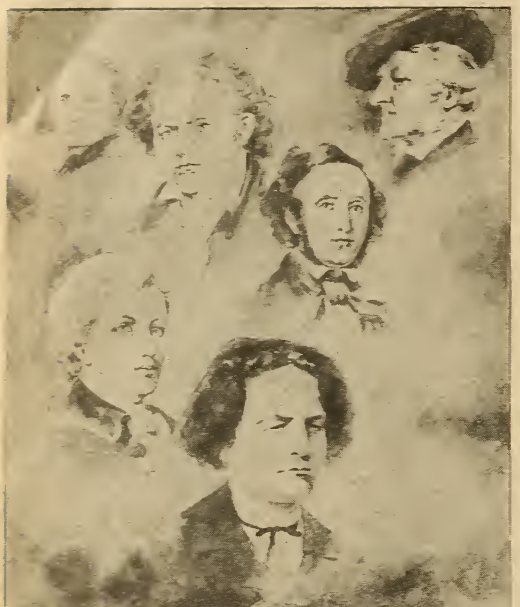

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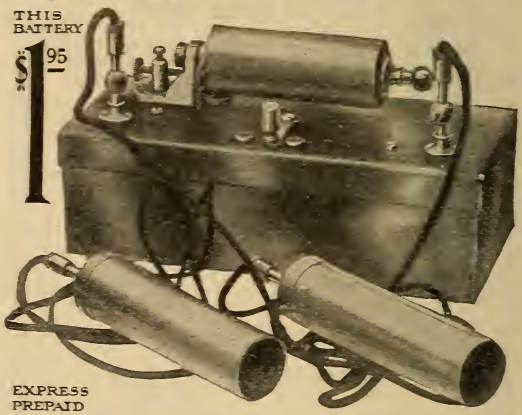

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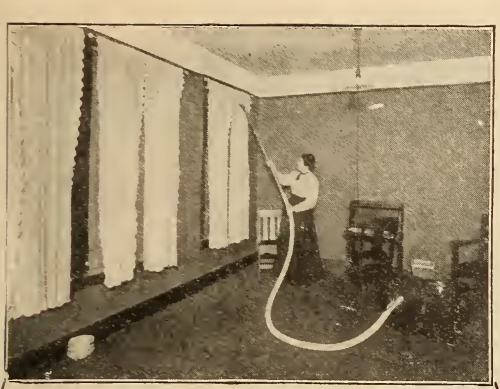

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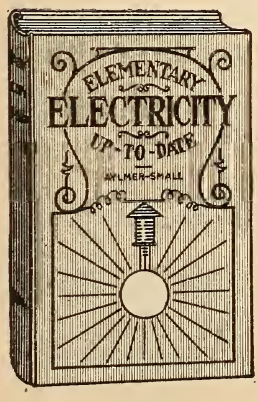

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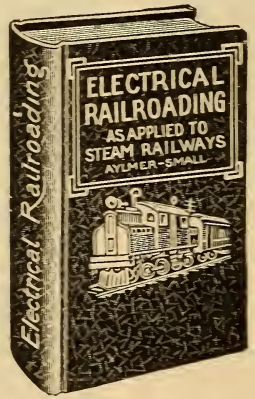

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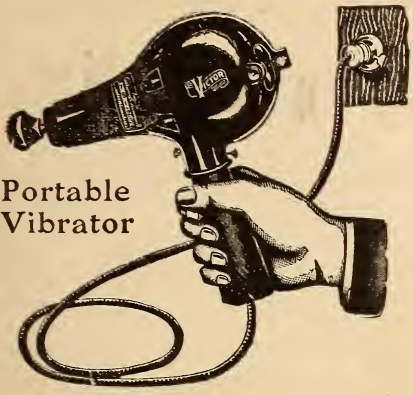

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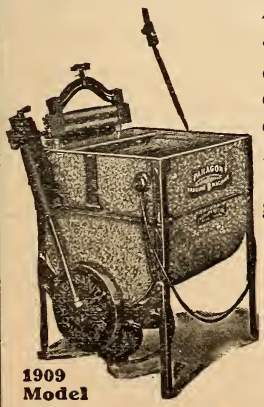

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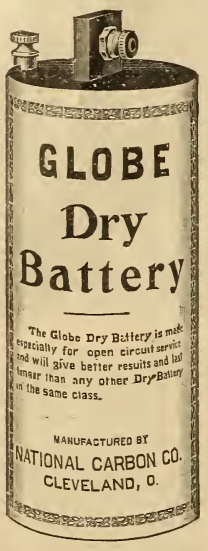
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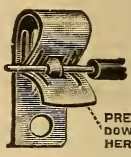

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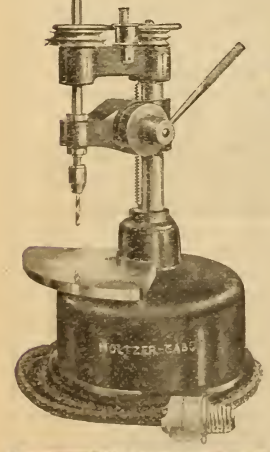

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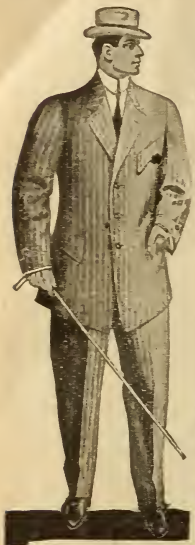

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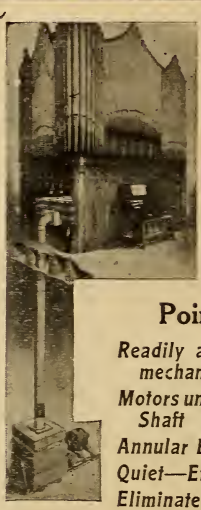

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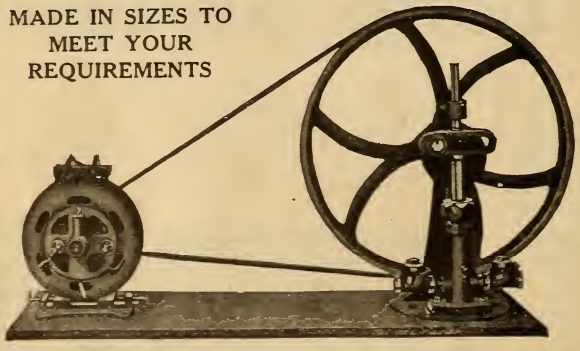

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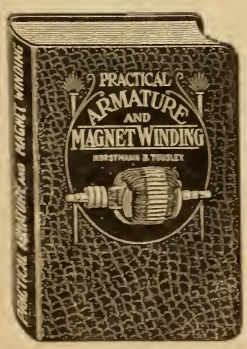

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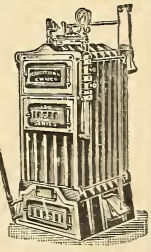

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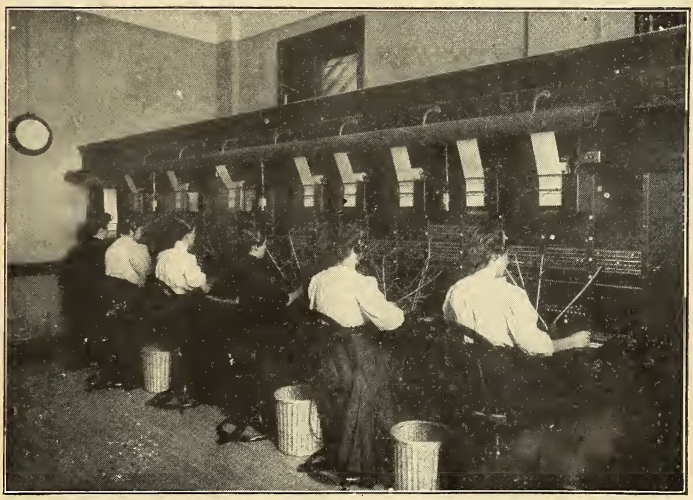

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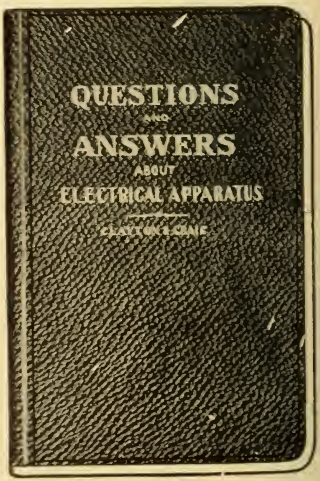

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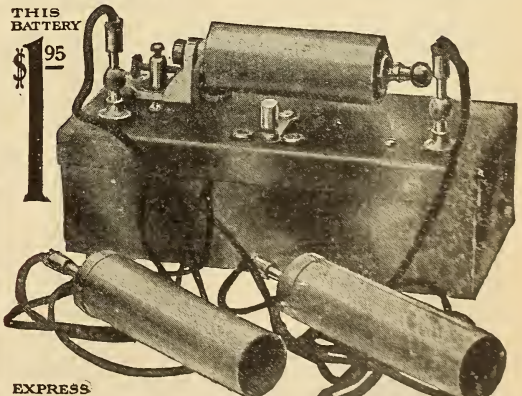

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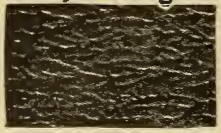

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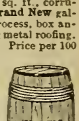

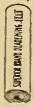

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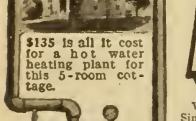

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Bath Tubs—Cast iron white porcelain enameled, high-grade and with nickel trimmings at $13.90. A number of slightly defective bath tubs without trimmings at $5.00 each.

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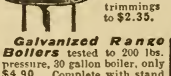

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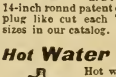

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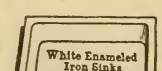
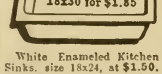


White Enameled Kitchen Sinks, size 18x24, at $1.50. Sink backs rolled rim, white porcelain enameled, 24 inch, at $1.50, 30 inch at $1.80.



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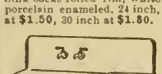

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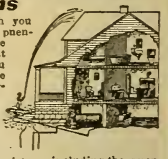

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IN PLAIN ENGLISH

HENRY WALTER YOUNG, Editor

Vol. II OCTOBER, 1909 No. 6

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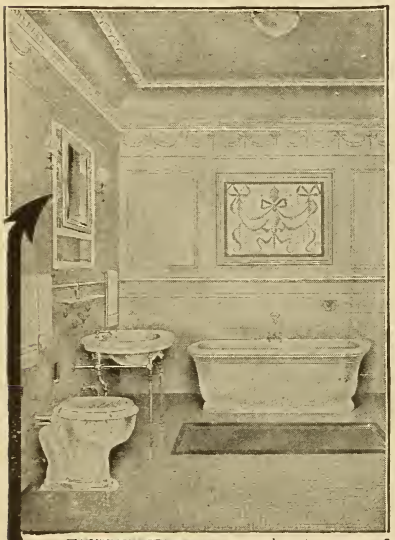
Hess Sanitary Bath Room Locker (Medicine Cabinet)

Something New For Your Home



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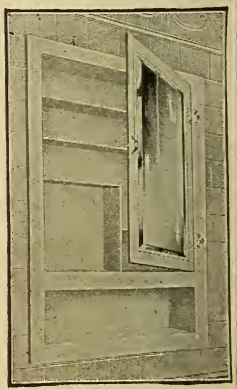

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Price Style "B" **9.00**
Without Mirror deduct $1.50
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1—Solenoid Magnet, ¼ lb.
1—Small Motor with Pulley.
4—Pair Electro-Magnets.
2—Miniature Lamps.
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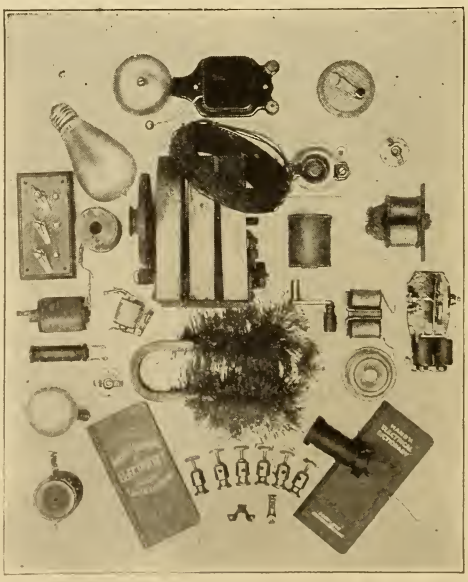

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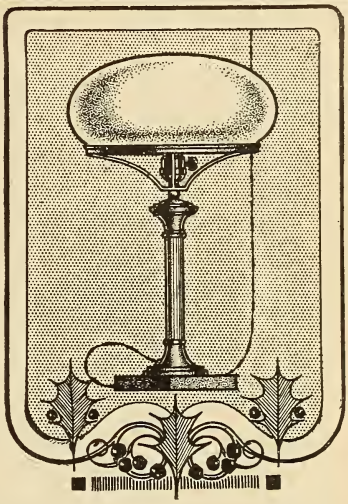

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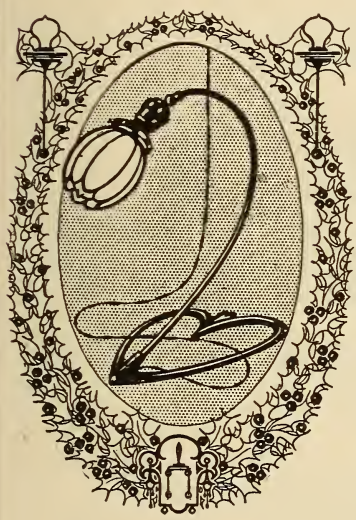

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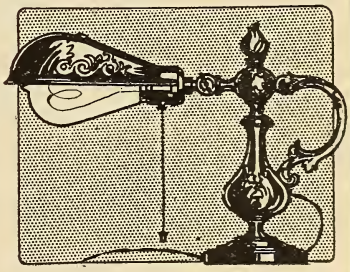
This unique and very artistic little lamp has been designed upon simple, yet most graceful lines. It may be hung on the wall or stood on a table. The socket may be tilted at any angle desired. Shade is frosted glass with leaded effect. Standard finished in handsome Brush Brass effect. Very popular for hall, library, desk, dresser or boudoir light. Price $4.00, express prepaid.

Electric Couch Bracket



This ingenious Couch Bracket for Electric Light has several uses. It may be hung upon the back of a bed to afford light to reclining readers. Or it may be placed upon the table or used as a piano lamp for illuminating music. Handsomely finished in antique brass, with cord and plug attached for $6.10, express prepaid.

The DIM-A-LITE Saves Current

Why should you burn a 16 candle power lamp, when a medium or dim light would serve the purpose as well? Every user of electric light will readily appreciate the advantage of being able to turn it down like gas. A dim light can be maintained in the hall, bathroom or sick chamber at a saving of 70% by using the Dim-a-lite—a plug device that screws into any Edison base socket. A slight pull of the cord gives either a high, medium or low light as desired. Nothing to burn out or replace. Makes every lamp a turn-down lamp. Gun Metal finish. By mail, Price $1.00.

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Here are a few of the hundreds of unsolicited testimonials from people who have used the White Cross Electric Vibrator and know what it has done. It will do the same for you.

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Upon the request of my sister, who urged me to use her great Electric Vibrator on my son when I was thoroughly hopeless of his cure from physicians' treatment, I write you this recommendation. My son is 16 years old, and eight months ago became paralyzed from the after-effects of diphtheria. He was so badly afflicted that his arms and limbs were twisted out of shape and was confined, all doubled up, in his bed. Medicine and attention did no good, and I had become discouraged in all ways. After treating first his spine at the base and then his limbs with your vibrator he felt such relief that I kept up the treatment regularly, with the result that we soon had him around in a wheel chair. Next he was going around on crutches, and now, after three months' treatment, he is going around with a cane and will soon be entirely cured.
3122 Indiana Ave., Chicago. MRS. C. KNIGHT.

WHAT A DOCTOR SAYS

I have received your Vibrator, and to say that I am well pleased with it is not enough. I wish I could tell every physician just how bad he needs one in his office. I am sure he would not hesitate to place his order for one at once.
Longmont, Colo. DR. W. H. EASTER.

VIBRATOR BEST FOR RHEUMATISM

My husband uses your vibrator for rheumatism and says he never had anything so good in all his experience. I would not be without it myself, as I find it is good to relieve stomach pains, back ache, and besides I continually use it for face massage. I used to go down town for that, while now I save the money and the time, besides being comfortable in my own home. MRS. S. H. BROWN,
2935 Vernon Ave., Chicago, Ill.

Here is a Picture of the wonderful WHITE CROSS ELECTRIC VIBRATOR, the only vibrator in the world which combines the three great forces of Vibration, Galvanic and Faradic Electricity. This is the very same machine which has cured thousands of cases which had been given up by the best physicians as incurable. Read the letters above, then send the free coupon at once.

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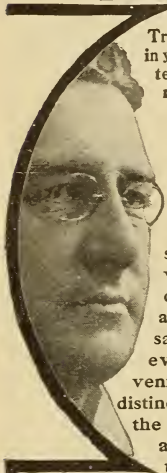

Try before you buy. Carry one in your pocket for ten days, try it—test it—make it sell itself to you or return it to the dealer. That's the way I want to sell my pens.

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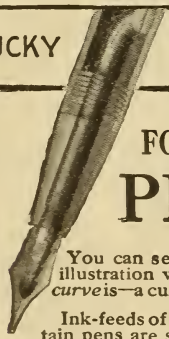
The Parker is the one fountain pen without limitations. Whatever your work is—no matter what may be the special requirements, you will find a Parker especially designed and adapted for it, and it will give good service, save your time, and be an ever-ready, efficient convenience. Besides all this, the distinctive feature of the Parker, the characteristic setting it apart from all other fountain pens is its perfect cleanliness, which is due to the *lucky curve.*

PARKER

LUCKY CURVE



FOUNTAIN PENS

You can see here in the illustration what the *lucky curve* is—a curved ink-feed.

Ink-feeds of all other fountain pens are straight. The difference between straight ink-feeds and the *lucky curve* is this—when you return a straight ink-feed pen to your pocket ink sticks in the feed until forced out into the cap by air expanded in the reservoir by the heat of your body, but, with the Parker, the *lucky curve* is self-draining, clearing itself of ink and giving air free passage.

Consequently you will never find the cap of the Parker full of ink, never soil your fingers or linen.

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Write for Free Trial. Our dealers will be glad to demonstrate, but where we have no dealer will ship the Hoover Electric Suction Sweeper direct. If you are not satisfied, return it at our expense, and the trial costs you nothing. Orders for machines on trial will be filled in order received. Write today for booklet and full information about trial plan. Do not delay if you want a machine promptly.

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Hoover Suction Sweeper Co.

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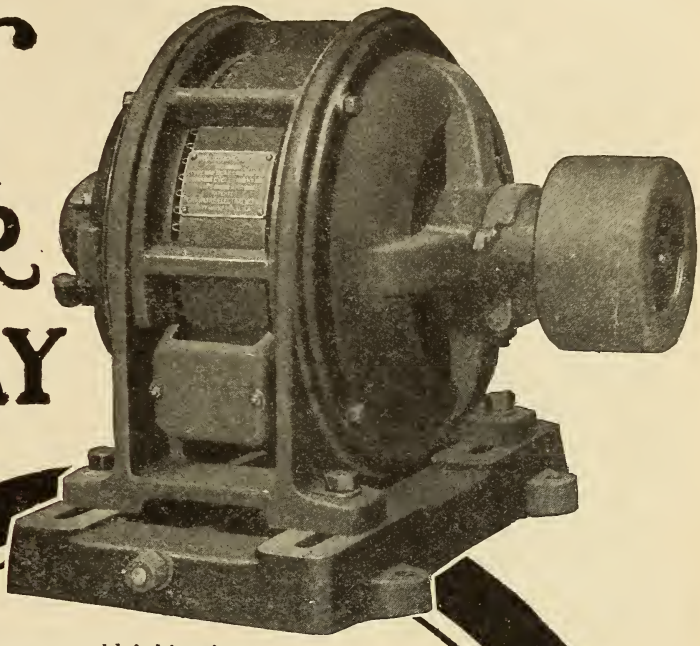

Your customers wouldn't hire six men to do the work that two could do with ease. Yet perhaps they continue to use six horse power to drive distant machines by old line-shaft methods, that only require about two horse power, when driven by our adjustable speed motors.

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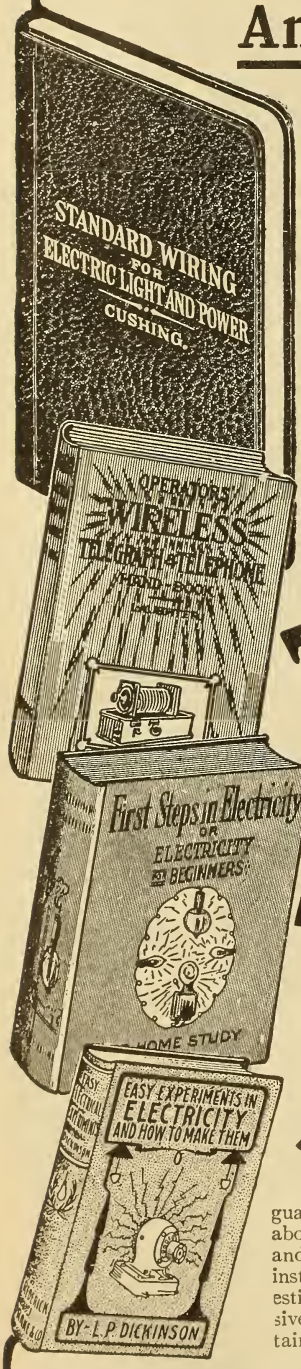
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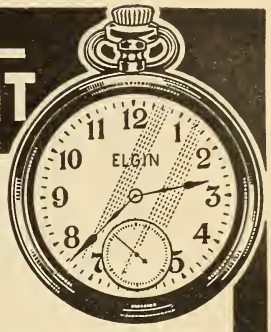

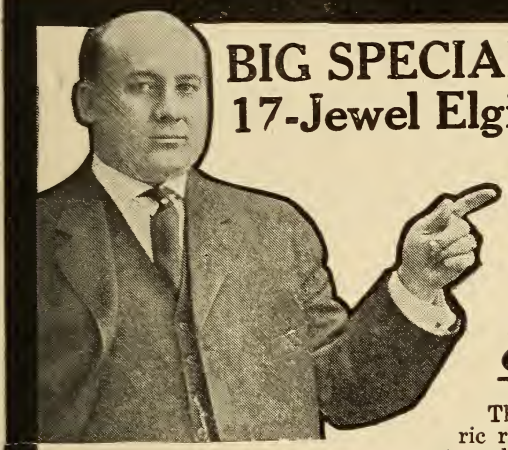

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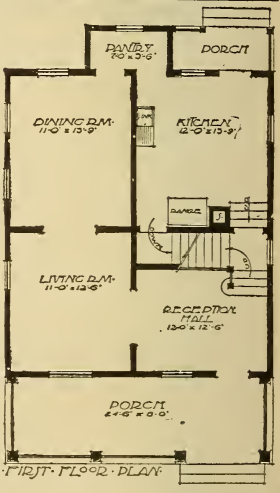

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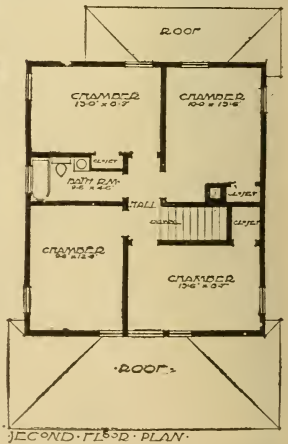

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IN PLAIN ENGLISH

VOL. II OCTOBER 1909 No. 6

ANDRE MARIE AMPERE

French Physicist, Mathematician and Naturalist

Ampere invented the astatic needle, of great value to science. He demonstrated that two currents of electricity passing through parallel conductors have an attractive or repellent influence upon one another according as they move in the same or opposite directions. He also made distinguished observations on terrestrial magnetism and earth currents, and established the connection of magnetism and electricity.

Andre Marie Ampere was born in Lyons, France, January 22, 1775, at the beginning of the American Revolution, and was destined to play a conspicuous part in the study of those forces and laws of Nature which were to so materially contribute to the peaceful revolution of the industrial world, and elevate his name and spirit into the company of the immortals.

He displayed his mathematical powers in early boyhood and attracted much public attention by one of his first essays "On the Mathematical Theory of Games of Chance." He gave the name Electrodynamics to that field of science in his "Theory of Electrodynamic Phenomena Deduced from Experiments." He also wrote on the "Undulatory Theory of Light," and an "Essay on the Philosophy of the Sciences, or an Analytical Exposition of a Natural Classification of all Human Knowledge."

He suggested the possibility, after his distinguished discoveries in electro-magnetism, of transmitting electric currents for signaling purposes by electro-magnetic apparatus, between distant points, which was realized in modern telegraphy. Michael Faraday subsequently worked out the fundamental principles of electro-magnetism by his extraordinary labor and results in experimental research.

Ampere was a man of deep emotions. His father was beheaded in France in 1791 during the revolution, producing in the young man a condition of great mental depression. From this after the lapse of a year he was restored to new life and energy by his readings of Rousseau and his love of Nature.

Later in life, again, this state of unhappy despondency fell over him from the death of his wife, whom he dearly loved.

He was distinguished and honored, a teacher and professor of great ability, Chevalier of the Legion of Honor, elected to the Academy of Sciences and heralded throughout the scientific circles of Europe for his discoveries in the field of electromagnetism and electrodynamics, and his announcement of Ampere's Rule, named in his honor by the leading body of scientists of his day. The ampere, named after him, is the unit of strength of an electric current.

Ampere was described as a man of genial disposition and noted for his simplicity of character. He died in the year 1836, at the age of sixty-one.

Elementary Electricity

By PROF. EDWIN J. HOUSTON, Ph. D. (Princeton)

CHAPTER XVIII.—SINGLE AND DOUBLE-FLUID VOLTAIC CELLS

As its name indicates, a single-fluid voltaic cell has a single electrolytic fluid into which its metals are dipped. There is required therefore a single vessel or cell only, to hold the electrolyte. In a double-fluid cell, however, when two different liquids are employed, it is, except in certain cases, necessary to employ two separate vessels to contain them. There are a great variety of both single and double-fluid voltaic cells, some of the more important of which will now be described.

Volta's original zinc-copper cell has undergone many modifications. In order to permit the zinc to be readily lifted out of the liquid, and thus avoid local action when the cell is not in use, various plans were adopted. In some cases the two elements were mounted on a suitable support. A voltaic battery of this character, represented in Fig. 116, was devised by Wollaston. The copper plate was bent so as to cause it to come near both sides of the zinc plate, accidental contact being avoided by pieces of wood placed as shown. Placing the negative plate in this way on both sides of the zinc decreases the resistance of the electrolyte by an increase in the active surface of the negative plate, and, consequently, by an increase in the cross-section of the electrolyte immediately between them. Then, too, since this form permits the two elements to be brought close together, a further decrease in the resistance of the electrolyte is ensured, by the decrease in its length between the two plates.

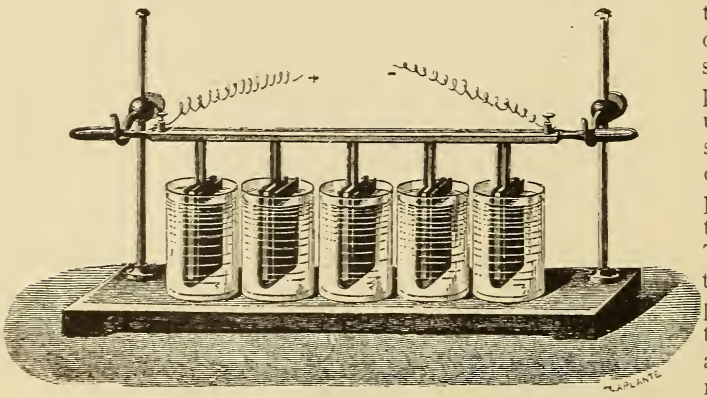


FIG. 116. WOLLASTON'S BATTERY

Where a large current is employed with only a small E. M. F., a single cell with very large plates was formerly employed. In the form devised by Dr. Hare, of Philadelphia, two large plates of zinc and copper were placed on each other, but prevented from touching by suitably placed strips of wood or other insulating material. The two sheets were then rolled in the form of a close spiral coil. This arrangement not only possesses the advantage of employing a large plate in a small space but also places the copper on both sides of the zinc plate. The spiral so formed was then plunged in a tub of acidulated water and arranged so as to be readily lifted out of the water and supported above the tub when the cell was not in use. The terminals or poles of the cell consisted of wires placed in good metallic contact with the plates of zinc and copper, the wire connected with the copper plate forming the positive pole or electrode, and that connected with the zinc, the negative pole or electrode. Hare called this cell a deflagrator, on account of the powerful heating effects he was able to produce with it.

It may here be said that at the present time, when powerful electric currents are required, electric sources consisting of voltaic cells are no longer employed, it being far more convenient to employ electric sources known as dynamo-electric machines, which will be described in a subsequent chapter.

A form of single-fluid voltaic cell capable of yielding fairly large currents for short intervals of time, is known as the Grenêt

or bi-chromate cell. It consists of a zinc-carbon couple immersed in an electrolyte known as electropoion liquid, prepared by dissolving one pound of bi-chromate of potash in 10 pounds of water, to which two and a half pounds of sulphuric acid are then gradually added. The zinc plate is placed between two carbon plates, so that both sides of the zinc are brought near the carbons. In order to avoid local action the zinc plate is attached to a movable rod which permits it to be raised out of the liquid when the cell is not in use. This cell is capable of producing an E. M. F., of about 1.9 volts. It rapidly polarizes, however, so that it cannot be satisfactorily employed for furnishing current for any considerable time. In this, as in all other cells in which zinc is employed, the zinc is carefully amalgamated.

There are other forms of single-fluid cells. These, however, are of comparatively little importance owing to the rapidity with which they are polarized. One of them, known as the Smee cell, consisted of a couple of zinc and silver inmmersed in an electrolyte of sulphuric acid and water. In order to decrease the polarization, the silver plate was provided with a roughened surface, by coating it with a thin layer of metallic platinum in the condition known as platinum black. The Smee cell gave an E. M. F. of .65 volts, and, before the introduction of the dynamo-electric machine, was employed to some extent in electroplating or coating conducting surfaces with thin layers of metal by electricity.

By far the most important voltaic cells are of the double-fluid type. As we shall employ this term it includes not only cells in which two different fluids are actually employed, but also those with a single fluid but in which the negative plate is surrounded by a solid substance capable of combining chemically with the hydrogen.

Where two different liquids are actually employed an additional cell called a porous cell, consisting of a jar of unglazed earthenware, is employed for holding the depolarizing electrolyte.

One of the earliest forms of double-fluid voltaic cells was invented by Grove, an English physicist. This cell, known as the Grove cell, consisted of a zinc platinum couple immersed respectively in dilute sulphuric acid and strong nitric acid. The nitric acid was contained in a porous cell of unglazed earthenware. Polarization was partly avoided by the fact that before the hydrogen could be set free, and collect on the surface of the platinum plate, it entered into combination with the oxygen in the nitric acid, and was thus oxidized so as to form water. The Grove cell is capable of producing an E. M. F. of 1.93 volts.

Owing to the cost of the platinum employed for the negative plate, the Grove voltaic cell was too expensive for extended

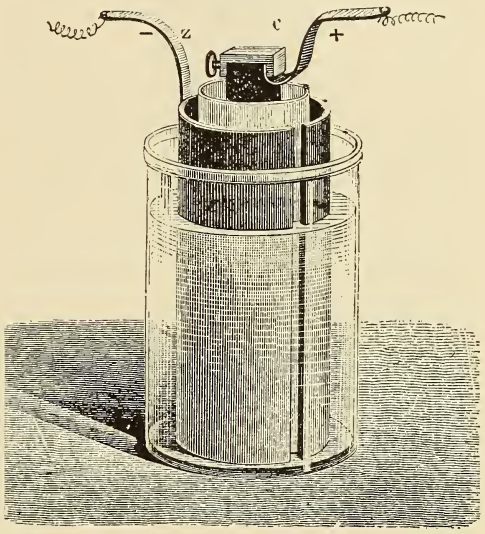


FIG. 117. BUNSEN CELL

use. It was replaced by a cell devised by Bunsen, the German chemist. In the Bunsen cell, as represented in Fig. 117, the platinum of the Grove cell is replaced by carbon. The elements are therefore zinc and carbon. The zinc is dipped in dilute sulphuric acid and the carbon in the strong nitric acid, placed in a porous jar or cell as shown. This cell will produce an E. M. F. of 1.96 volts.

None of the cells so far described is capable of producing a steady or constant current for an indefinite time. It was not until Prof. Daniell, of London, in 1836, employed the electro-chemical method of avoiding polarization, that a cell capable of furnishing a steady current for a practically indefinite time was produced.

The Daniell constant voltaic cell, as shown in Fig. 118, consisted of a couple of zinc and copper immersed respectively in dilute sulphuric acid and a saturated solution of blue vitriol or copper sulphate. The two

solutions are kept from mingling by the use of a porous cell containing the copper sulphate. The zinc was made in the form of a cylinder surrounding the porous cell, and the copper plate was provided with a perforated cage supported near its top so that when filled with a handful of crystals of copper sulphate the lower portion of the

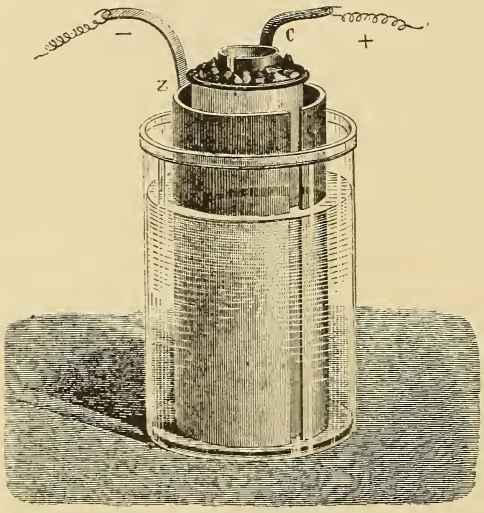


FIG. 118. DANIELL CELL

crystals was immersed in the solution of copper sulphate into which the copper plate was dipped. This cell produces a practically constant E. M. F., of about 1.072 volts, for an indefinite time, thus showing that all polarization has been prevented.

The action of the cell is as follows: the sulphuric acid acts on the zinc, forming zinc sulphate, and liberating hydrogen gas which passes through the porous cell. Before the hydrogen can reach the copper plate, however, it meets the saturated solution of copper sulphate which it decomposes, liberating free sulphuric acid, and depositing metallic copper on the surface of the plate. The strength of the sulphuric acid electrolyte is maintained practically constant, since for every molecule of the acid that combines with the zinc, a molecule of zinc sulphate is formed, and sufficient hydrogen liberated to again form a molecule of sulphuric acid when this hydrogen decomposes the molecule of copper sulphate, for the sulphuric acid liberated passes through the pores of the cell into the dilute acid into which the zinc plate is dipped.

As the strength of the solution of copper sulphate is decreased by its decomposition of the hydrogen, a portion of the crystals of copper sulphate is dissolved from the cage that dips into the solution, thus maintaining a saturated solution.

In actual practice the metallic copper is sometimes deposited on the outside of the porous cell, thus greatly increasing the electric resistance of the cell. In order to avoid this an improved form of Daniell's cell has been devised, known as the gravity cell, whereby the use of a porous cell is avoided, the two electrolytes being separated from each other by their differences of density, the lighter diluted sulphuric acid and zinc sulphate, floating on the top of the denser copper sulphate.

Varying forms are given to the gravity Daniell cell. That employed in America is shown in Fig. 119. Here, the zinc has the shape of an open wheel suspended by suitable supports near the top of the glass cell, while the copper plate, placed at the bottom of the jar, is covered with a few hand-

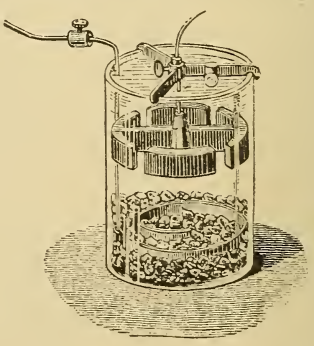


FIG. 119. GRAVITY CELL, AMERICAN TYPE

fuls of crystals of copper sulphate. An insulated wire, connected with the copper plate, passes up through the liquid and forms the copper or positive pole of the cell.

The gravity cell will furnish a steady current for a long time without much attention, it being only necessary occasionally to throw into the cell a handful of crystals of copper sulphate, to renew the water on top of the liquid that is lost by evaporation, and occasionally to draw off a portion of the zinc sulphate when it becomes too concentrated.

An important double-fluid cell is known as the Leclanche cell. The voltaic couple is

zinc and carbon. The carbon element consists of a carbon plate, placed inside a porous cell closely packed with a mixture of powdered carbon and black oxide of manganese. This packing is sufficiently

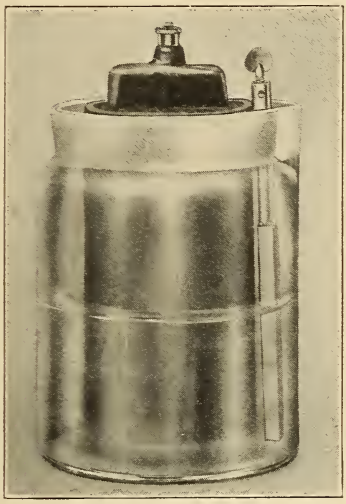


FIG. 120. LECLANCHE CELL

strong to insure a good electric contact between the carbon plate and the packed material. The zinc consists of a small rod placed in one corner of the glass jar in which the porous cell is placed, as shown in Fig. 120. The electrolyte is sal-ammoniac dissolved in water, this liquid being poured both into the outer jar as well as into the porous cell. The black oxide of manganese that surrounds the carbon plate acts as the additional de-polarizing substance.

The Leclanche cell is capable of producing an E. M. F. of 1.47 volts, and of furnishing a fairly strong current for a short time. It is, therefore, suitable for the operation of such electro-receptive devices as the bells of burglar alarms, annunciators, etc., that are only employed for short times; for, owing to the presence of the black oxide of manganese, the cell, if left on open circuit for a sufficient length of time, is completely de-polarized. The Laclanche cell is therefore called an open-circuited cell, since it requires to be left on open circuit in order to be satisfactorily operated.

The Laclanche cell is used in enormous numbers in connection with electric bells. When not used too frequently it will continue in satisfactory use for six months or a year without requiring any attention.

A recently devised double-fluid cell known as the Edison-Lalande cell, consists of a couple of zinc and copper immersed in an electrolyte of caustic potash or soda dissolved in water. The copper plate is prevented from polarizing by a coating of compressed oxide of copper. This cell is

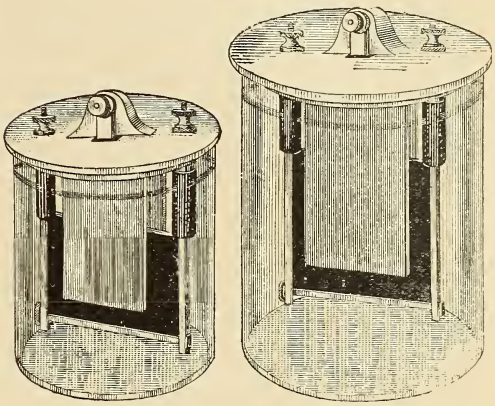


FIG. 121. EDISON-LALANDE CELL

capable of giving a powerful current for a fairly long time without marked polarization. Nor does it manifest marked local action when left on open circuit. An Edison-Lalande cell is shown in Fig. 121.

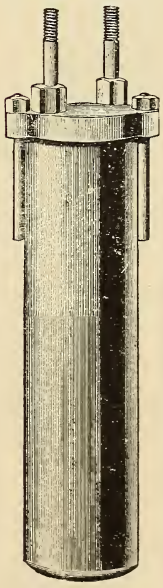


FIG. 122. SILVER-CHLORIDE CELL

A variety of voltaic cell known as the silver-chloride cell is employed in the series batteries used for medical purposes. This cell consists of a couple of zinc and silver immersed in an aqueous solution of sal-ammoniac or common salt. The silver element is formed of a silver wire that is surrounded by a mass of fused silver chloride. The zinc and silver plates are prevented from coming in contact by pieces of suitably placed insulating material. The two elements are placed inside a rubber jar, Fig. 122, containing the exciting liquid, a dilute solution of sal-ammoniac in water.

The advantage of the silver-chloride cell is to be found in its portability. As many as fifty separate cells can be placed in a

frame connected in series as shown in Fig. 123, and placed in a wooden box, Fig. 124, with the entire battery weighing in the neighborhood of but ten pounds. The

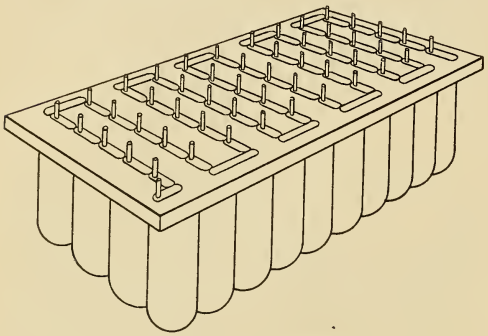


FIG. 123. ARRANGEMENT OF SILVER-CHLORIDE CELLS

silver-chloride cell can produce an electromotive force of 1.03 volts. Owing to the small size of its cells, however, it cannot furnish very powerful currents. It is especially useful when feeble current and high electromotive forces are required.

The inconvenience of carrying voltaic cells from place to place has led to the invention of what are known as dry cells

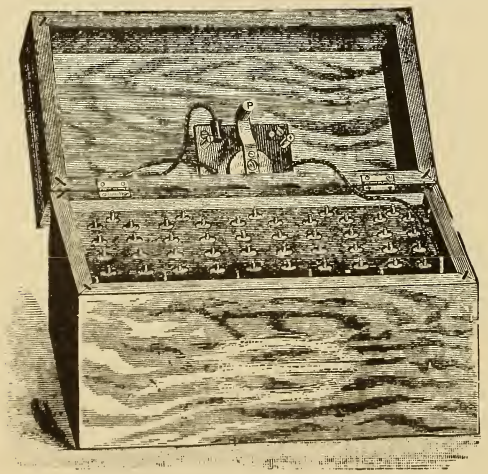


FIG. 124. BOXING OF SILVER-CHLORIDE CELLS

with which nearly every one is familiar. This name is a misnomer, since all dry cells contain water that has been absorbed, by sawdust, plaster of paris, or gelatine, and is thus prevented from splashing when carried about. The electrolyte is generally a solution of sal-ammoniac and water, and the couple, like the Leclanche cell, consists of zinc and carbon.

Voltaic cells are sometimes called galvanic cells, and the electricity produced was formerly known as galvanic electricity. The use of either of these names is, however, incorrect, since it was Volta and not Galvani who invented the electric source that produces electricity by means of chemical action.

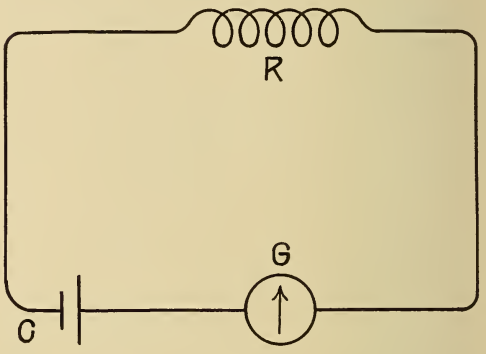


FIG. 125. SYMBOL FOR REPRESENTING A VOLTAIC CELL IN CIRCUIT

For convenience the following symbol is employed in electric diagrams for representing a voltiac cell. As will be seen this symbol consists of two lines of unequal length that represent the two elements of a voltaic couple, the space between them, indicating the electrolyte. In Fig. 125, (C) represents a voltaic cell, (R) a resistance coil, and (G) a galvanometer, all of these being placed in series with the voltaic cell.

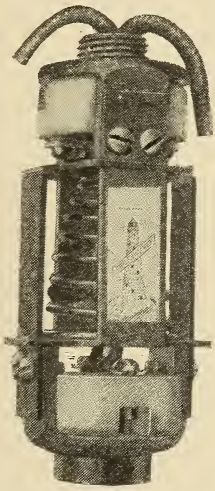
(To be Continued.)

Hydroelectric Power for Chattanooga

Manufacturing in Chattanooga entered on a new and greater epoch on June 17th, when electricity from the 56,000 horse-power plant at the lock and dam was sent over transmission wires into the heart of the city. Four years ago the Chattanooga and Tennessee River Power company obtained a franchise to operate in the city, on condition that electricity be sent over the wires in four years, and by turning on the current on the 17th the company fulfilled the terms of the contract, for the four years would not have expired until the 19th. The plant generating power, second in immensity only to that of Niagara Falls, is now in steady operation.

The Tungsten Life Saver

Filaments of the tungsten lamps are not as strong and will not withstand vibration and shock as well as the carbon filaments of the ordinary lamps, although their efficiency and light giving properties are far in advance of anything thus far developed in the line of electric incandescent lighting. The first tungsten lamps produced for commercial purposes were very fragile and would only operate in a vertical position. Upon the least jar they were broken. Since then great improvements have been made, such as anchoring the filaments, etc., which makes the lamp much more practicable. However,



TUNGSTEN LIFE SAVER

they are even now not vibration proof and accidentally striking the electrolier or bracket is apt to result in the destruction of the lamp filament.

The idea to protect the entire lighting fixture and thus stop the effects of the shock at a point as far removed from the lamp as possible has resulted in a little device known as the tungsten "life-saver." It consists of a very sensitive coiled spring arranged between two stirrup-like hangers. This spring is smaller at the top than at the bottom and permits of a lateral oscillatory motion in every direction. The hangers are supported by this spring and are also free to move in a lateral direction. The lighting fixture support is screwed into a receptacle attached to the strap hangers, the whole device being fastened to the ceiling.

Any constant vibration as in factories, engine rooms, etc., is taken care of by the spring which also neutralizes any shock resulting from a sidewise or vertical blow on the fixture.

When Ordering Motors

To many people a motor is a motor and in ordering one from the manufacturer they frequently give little information other than the horsepower required. As a consequence there is much unnecessary correspondence and delay. It is well to bear in mind, therefore, that the information given can hardly be too explicit. Let the manufacturer know in the beginning exactly what it is that you want.

In the first place he must know whether it is a direct or alternating current motor that you require. This of course depends upon the nature of the current that you have available. Then he must know the voltage of the circuit, whether alternating or direct, and the number of horsepower required. If it is an alternating current motor give the frequency of the alternations in cycles per second, also whether it is to run in one two or three phases of the current. The above data as to voltage, kind of current, frequency, etc., you can obtain from the lighting company which supplies your current.

The above are the fundamentals, but there is other information which it is well to give the manufacturer. Tell him the nature of the machine which your motor is to run; what the speed of the machine is to be and the size of its pulley (in order to determine the speed and size of motor pulley). Explain the nature of the location of the motor, whether in a wet or dry place, whether well ventilated or confined, etc. Also, if the motor must be confined in close quarters give the dimensions of the space available. Motors have been shipped which could not be used because of insufficient room. Also tell whether the motor is to run steadily on full or partial load.

If there is anything special about the service be sure and explain it. For instance, if a very heavy torque or turning power is required to start the machine as compared with the running power.

If it is desirable that the motor have automatic starting and stopping devices mention the fact and the manufacturer, knowing the conditions of the service, will be able to suggest appliances for doing this.

Making Old Poles New

The users of wooden poles are suffering especially from the failing supply of timber in this country. The qualities required in a good pole—durability, light weight and straightness—combined with relative smallness are most readily met by cedar. This wood has most generally been used for poles, with chestnut as a somewhat distant second; these woods, in fact, affording over 80 per cent of the poles used. A result of the enormous consumption, coupled with the wasteful and extravagant methods of cutting and use, has been to restrict the regions from which the present supply is obtained. The nearby timber was naturally used first, and at the present time the supply of cedar poles is confined almost entirely to the Lake States, the Northwest and parts of the Adirondacks. The region from which chestnut poles are obtained is even narrower, Pennsylvania, Maryland, Virginia and West Virginia furnishing the bulk. This means that the consumer, in addition to paying a higher price, due to increasing demand and decreasing supply, must in many cases add a higher transportation charge.

In 95 per cent of the cases the life of a pole is determined by decay, and only five per cent by breakage or mechanical abrasion. The point of decay is right above and below the ground level, as there the structure of wood is most susceptible to fungi and bacteria, which are living organisms and thrive only in a condition of moisture. Consequently, in practically every case of a pole which has decayed at the butt the portion above ground is sound and would be good for many years' service. Of late years there

STEPS IN THE METHOD OF POLE REENFORCEMENT

has been much experimenting with preservatives, applied to both the entire pole, but in most cases to the butt only. Much progress has been made, and with many companies the lower portion of the pole receives one or two coats of some preservative before setting. The government reports show that in 1907 over 11 per cent of

SECTIONAL VIEW OF REENFORCED POLE

the number purchased received some preservative treatment.

However much good these means accomplish, as far as the poles now standing are concerned (and there are estimated to be over 50,000,000 poles in use in this country) it seems very largely an instance of "locking the stable after the horse is stolen," as it is impractical to apply preservative treatment to a pole which has been standing for some time. When the butt is decayed to such an extent as to render a pole dangerous, a new pole must be put in, unless by some process the butt can be strengthened in an adequate fashion, and the sound upper portion continued in service.

The Pittsburg reenforcing process for extending the life of poles already decayed is one which is gaining ground rapidly and where employed is saving many thousands of dollars for the telephone and lighting companies. The pole to be reenforced is supported by tripods or held securely in place by temporary guy ropes or wires; the earth is then removed for a distance of about eighteen inches from the sides of the pole to a depth that will expose the solid portion of the butt remaining. The decayed portion of the pole is then scraped out. Half inch steel rod from three and a half feet to six feet long and pointed at both ends, the upper end being bent at right angles to form a dog or point from five inches to six inches long, are used for reinforcing. The straight end of the rod is driven into the sound portion of the butt at an angle by the use of a special driving tool. The upper portion of the rod is then bent in toward the pole and the dog driven in to its full length.

The length of the rod is such as to permit the proper anchorage of its lower end in the sound wood of the butt and to allow the portion extending above ground to be of sufficient length to span the decayed section of the pole and be driven into perfectly sound wood. The points of the rod are usually driven into the pole from 12 inches to 18 inches above the ground level. Concrete is filled in around the pole, replacing the decayed portion of the wood and forming a protecting sleeve or envelope. This concrete extends above the ground sufficiently far to cover the upper terminals of the rods and protect them from the action of the moisture in the air.

The above process is patented and of course those using it without license would be liable to infringement proceedings.

Tubelite Reflector

A new type of reflector for illuminating show windows and show cases is called the "Tubelite" reflector. It occupies space only 2¼ inches in width and can be made in any length up to 10 feet, without seams. It can be turned out with bright, nickel reflecting surface, matt finish, or lined with glass and finished on the outside to match woodwork. When desired, the reflector is supplied with adjustable fittings. Wiring trough and sockets can be removed without disturbing the reflector. Another feature is that standard base tubular lamps are used, which lamps can be purchased in any electrical supply store, and should a lamp burn out, there will be only a six-inch unlighted space. Illuminations from eight to 64-candle power per foot can be obtained.

TUBELITE REFLECTOR

How Cities Advertise

Any one riding into the city of Easton, Pa., over its principal railroad, after dark, sees the big slogan sign which reads: "Easton —City of Resources." Passengers crowding out by a firm of central station operators, who from past experience in other cities, where their plants are in successful operation, realize that co-operation between the

to the car windows first see two arrows of green light shoot out horizontally, pointing out the breadth of the city. Then a red sun looms up behind the green horizon. Suddenly athwart the sun the word "Easton" breaks out in letters of white light, and finally as the rays of the sun die away, the words "City of Resources" are flashed forth in a line of five-foot white letters. This great sign, installed through the co-operation of the Easton Gas and Electric Co. and the Easton Board of Trade, measures 54 by 45 feet over all and contains 2,000 electric incandescents. It was furnished to the city and is maintained in operation by the electric company and is a proof of the power of a progressive and broad minded central station company to invigorate a community.

Less than a year ago the old lighting company operating in Easton was bought company and the citizens in the general up-lift of the city is essential. "All get together and boost for the city" is the principle upon which they operate, so meetings were called of the prominent business men and property owners. New enthusiasm was put into the Board of Trade. Lantern slide lectures were given, demonstrating the advantages of outdoor display lighting and finally the great slogan sign was put up.

All these things have had a remarkable effect not only in arousing new activities in Easton, but also in getting the city talked about, far and wide, as the city of resources.

Much the same thing has been done in Montgomery, Ala. In this case it was the Montgomery Light and Water Power Co. which took the initiative and introduced the slogan, "Montgomery—Your Opportunity." In this case also a great sign,

contributed by the power company, blazes out by night a welcome to this progressive city of the South.

The sign was first lighted on Tuesday evening at 8 o'clock, July 20, 1909. Its brilliance rendered superfluous the fireworks in the sparks of which it received its baptism. With its mammoth red key transfixed against the sky and with the lettering, "Montgomery" and "Your Opportunity" playing on and off, it elicited great cheers from the crowd gathered to witness the dedication. The cavalry band was there, playing the march, "Montgomery, Your Opportunity," written especially in honor of the sign.

That the mammoth sign to be built should bear some slogan indicative of the city's progress and possibilities was agreed upon. As to what the slogan should be was left to the citizens. A contest was begun open to all citizens, who were to offer suggestions. Twenty-five citizens of prominence were named as a committee of judges to decide on the slogan.

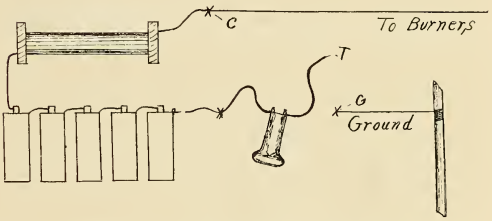
The slogan as finally adopted was the outcome of a dual intellect. Miss Anita Strassburger conceived the idea of the key, and Mr. Gordon McKinley, a reporter on the Montgomery Advertiser, originated the "Montgomery, Your Opportunity," wording. Thus the conception was carried into execution. The sign was built—a tremendous skeleton, containing 2,600 electric bulbs in letters about six feet high.

The sign is 85 feet in length and about 75 feet from top to bottom, and is located at Court and Jefferson streets. All railway trains in passing the city of Montgomery are in sight of this great sign when lighted at night.

Telephone Receiver as a Testing Instrument

An ordinary telephone receiver is one of the most useful accessories of the amateur electrician, as it is very useful for testing electric gas lighting, electric bell, and similar circuits for leakage. Two flexible leads about 18 inches long should be carried from the binding posts of the receiver for connecting, and for testing, this little instrument will many times take the place of a more expensive one.

The accompanying diagram shows how it may be used to test gas lighting circuits. One terminal of the receiver is connected to the battery which is usually grounded, the ground connection being temporarily broken. The other terminal (T) of the receiver is then applied to the burner circuit where it leaves the spark coil at (C), being put in contact with, and removed from the wire several times in order to note clearly the strength of the click caused in the receiver. Then the free terminal (T) is touched repeatedly to the ground connection or a gas pipe. If there is any leakage a click will be heard, and a comparison of the sounds obtained in the last test with those



TEST BY TELEPHONE RECEIVER

obtained when the receiver is connceted to the spark coil terminal will give a good indication of the extent of the leakage. If no click is heard when the receiver is connected to the ground and battery, then the circuit is clear, assuming, of course, that the wires from the spark coil to the burners are all sound.

The same method may be applied to electric bell circuits, in this case there is no spark coil, so that the terminal (T) is touched to the circuit terminal of the batteries in the first part of the test and to the ground or common return wire in the second. The receiver can also be used to tell whether or not a bell rings when a button is pushed, by connecting the receiver terminals to the contacts of the push-button and pressing the button two or three times. If a buzzing noise is heard in the receiver after the connection between the push-button contact is broken, then the bell rings. If the bell does not ring, the receiver will merely give a single click, and if the circuit is broken between the button and the bell, no sound will be heard in the receiver.

The receiver, in connection with a few cells of battery, can also be used to test dynamo and motor windings.

Profits that Electricity Brought

In a certain village in New England is located a textile mill. Now there is nothing strange or peculiar about this insignificant fact for textile mills are more or less common in New England. But this textile mill has added interest in that it is one of the oldest in the state, if not in the whole country.

Time was when this little factory hummed merrily by day through power obtained from a small creek which very seldom ran low and never went dry. But the settlements pushed further and further into the hills and before them vanished the great forests; they cleared the land for planting, and the green Irishmen ditched the farms until the spring-fed swails and swamps were things of the past. Before such inroads on nature's scheme for retarding the waters to keep the brooks and streams constant the power vanished. In the Springs and during heavy thaws or rains there was an abundance of power but there being no provisions to substitute nature's plan for storing this water it all ran away before it could be used and the water power became practically useless.

Very fortunately for the milling industry about this time human minds had perfected the steam engine to take the place of the damaged water powers. It is our greatest prerogative to first destroy a thing then to cast about until a substitute is found.

This mill was a paying institution and as soon as it was found that the water power was inadequate and unreliable the proprietors got their heads together and purchased a steam engine. A large power house was erected and in it was installed two huge boilers and a large reciprocating engine. Sweating, grimy men stood before the furnace doors and heaved coal into the fiery maw of the boilers. Another man in oil stained overalls and dicky watched the giant engine, the spinning fly wheel of mammoth proportions and the great leather belt which consumed hundreds of steer hides in the making. This leather belt turned the great shaft which had been run so many, many years by the noisy creek. The water wheel was abandoned and the dam was repaired and kept merely as a source of water for the boilers.

Year after year, year after year the great arm of this steam engine moved back and forth, back and forth, for ten hours a day in its well oiled bearing, spinning the great fly wheel and driving the great leather belt. As the years went by hundreds of thousands of dollars worth of good coal were hauled into the mill in the coal cars and thrown into the red furnaces. This was money almost thrown away if we consider the days when the noisy stream did the same work for nothing. But the stream, like a played-out horse, would never work again and the more costly energy of coal had to he employed or the mill closed.

About this time the cost of coal in carload lots began to increase so fast it threatened the profits of the mill and it began to look as though the plant would have to close.

One day the managers called the engineer into the office and told him that the profits of the concern were being eaten up in the power house and asked him for advice.

"This plant has always been a success and thousands of honest dollars have been made right here," remarked the president. "but unless steps are taken at once to lower the power cost we will have to close down. Competition is so severe we can ask no more for our goods and sell them. Our help here in the country is the cheapest to be obtained anywhere. It is only a question of cheaper power."

"Ah, if that old creek was what it was when I was a boy," sighed one of the aged directors.

"But it isn't," answered the young engineer, "and it never will be again. I have been seriously considering this power question myself and there are but two logical solutions. We have an old water power which might be restored if large storage reservoirs were erected. I have looked the ground over and hate to report that it would take a fortune to purchase the land required for such a dam and another fortune to erect the dam itself."

"And what is the other solution?" asked a director.

"Electricity," answered the engineer, very enthusiastically.

"But where are we to get the electricity?" asked the president. "We are far away from any electrical power producing stations and it would cost us just as much to produce electricity as it does steam power."

"And that is very true," remarked the engineer, very much interested in his subject, "but with electric drive installed in that plant the output of every machine would be increased from 15 to 20 percent, for the same cost as at present. This in itself would mean a handsome profit for the firm. Then we would not be wasting 20 percent of our power to turn useless shafting and belting."

"Prove that statement," cried the president, now thoroughly aroused.

"And, furthermore, I would recommend that that old steam engine be thrown on the junk heap," continued the engineer.

"But that engine cost ——," cried one of the directors.

"I don't care what it cost," answered the young man. "It has paid for itself already many times over and it is too costly and too extravagant in fuel and power for this day and age. What we must have is a small turbine engine, direct connected to an electrical generator, and equip this plant with motor drive and electric lights. Such a plant would cost considerable but it would pay in the end. It would save power and coal and increase the production without increasing the factory cost."

"Prove it," cried the president.

It took days and days to prove these statements to the directors but in the end the young man's determination won the day, but not until he carefully checked every statement through competent engineers.

The expenditure was authorized and the young man himself was sent to buy a steam turbine engine direct connected to an electrical generator. He also ordered the electric motors and the other necessities.

The mill was closed for a whole month and during that time the busy workmen removed the faithful old engine and threw it on the junk heap. The boilers were repaired and an automatic stoker installed to take the place of the sweaty, grimy firemen. It is worthy of note that the directors shook their heads when they saw the steam turbine setting up in the center of the large power house, looking pitifully small and inadequate to take the place of the giant just removed. It took all the engineer's time for hours explaining that the size of the new turbine had little to do with its power and as a matter of fact the small engine could develop a third more power than the old one, if necessary, although it took up less than a quarter of the floor space.

The huge fly wheel was tenderly laid on the junk heap beside the engine and the wide leather belt, made of hundreds of steer hides, was thrown away. Great quantities of belts, shafts and pulleys were also thrown on this same junk pile until the interior of the working rooms of this textile mill looked as though a forest of trees and fixtures had been removed. The light was far better and the men and women had more room to work and less danger from shaft ends and breaking belts to face. The mill was completely lighted by electricity.

When the mill reopened the young engineer was sufficiently conversant with electrical power to take care of the turbine and generator and to operate all the other electrical machinery. The turbine started smooth and steady, running without a jar and with very little noise. The motors throughout the plant drove the machinery as never before and the president and directors, to say nothing about the operators themselves, were perfectly delighted with the new power.

"Better not rejoice too much until we see the balance sheet at the end of the month," cautioned one old man who was noted for his wealth and his pessimism.

"It will show a good saving," predicted the young engineer.

While it is true that the balance sheet for the first month did not show as large a saving as was anticipated, owing to the machinery being all new and the men unfamiliar with its use and management, the saving grew from month to month until the profits for the little textile mill were restored to their old order and everyone, including the pessimistic one, was satisfied and pleased with the new electric power.

Storage Battery Mine Locomotives

By FRANK C. PERKINS

In Europe there are a number of mines which have been equipped with electric storage battery locomotives of unique construction, the batteries being mounted on the top and removable for charging, by means of a special gearing with permanent rolls fixed in the top of the locomotive frame. By providing this equipment it is possible to remove the discharged batteries and provide fully charged battery sets with a minimum expenditure of labor in making the exchange.

One of four locomotives in use at the Grillo shaft of the Monopol mine owned by the Gilsenkirchener Bergwerks-Aktiengesellschaft may be seen in Fig. 1. In Fig. 2 are seen the batteries removed from the locomotives and being charged on the charging tables. The electric motors are of eight horse power capacity, and there are 10 storage battery sets at this mine, in service, each set contains 80 cells having a capacity of 30 ampere hours each.

The storage battery locomotives are said to have several advantages over those operated by overhead trolleys or third-rail conductors almost universally used in this country. They are held to be very much safer in mines containing dangerous gases, there being no sparking from third-rail or trolley. They also have a large radius of action without extensive overhead construction.

FIG. 1. STORAGE BATTERY LOCOMOTIVE IN THE MONOPOL MINE

In Hungary at the Petrozeseny Mine there are eight storage battery locomotives in service of the type shown in Fig. 3, each having motors of a capacity of 12 horse power. These locomotives are operated in pairs, the double locomotive thus formed having a capacity of 24 horse power and

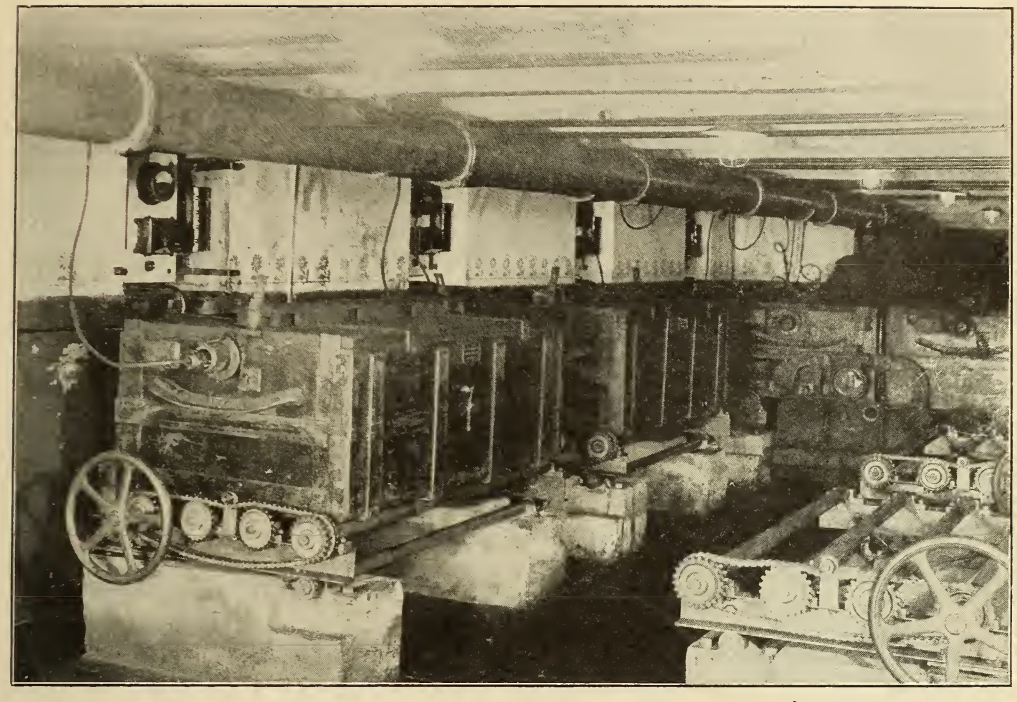


FIG. 2. LOCOMOTIVE BATTERIES BEING RECHARGED

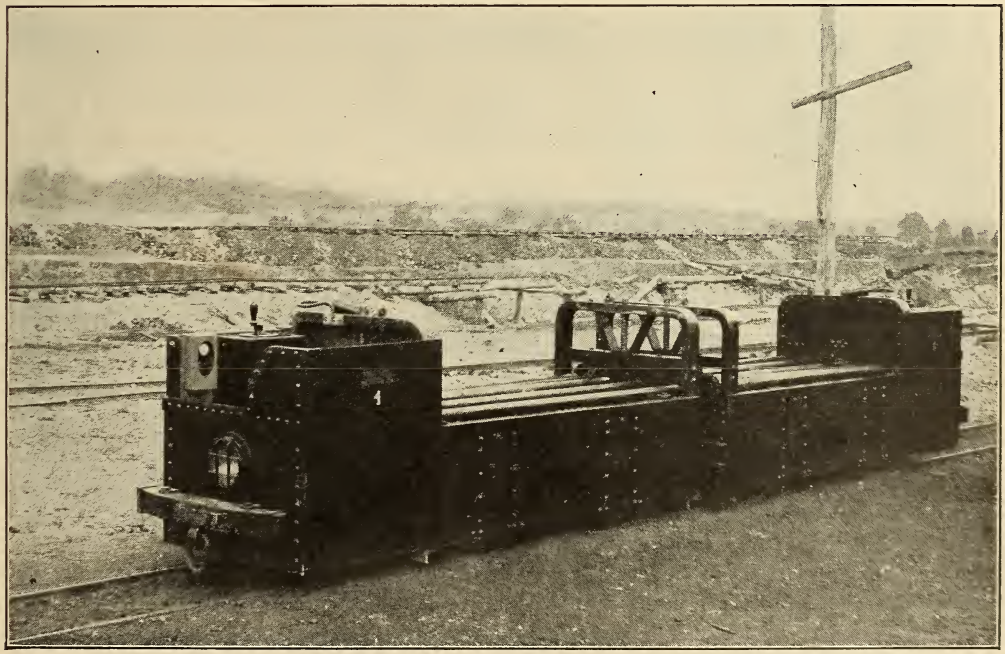


FIG. 3. TANDEM LOCOMOTIVE USED IN A HUNGARIAN MINE

being capable of hauling 40 coal cars without difficutly. At this mine there are 16 sets of batteries used, of the Tudor type, built at Budapest, and each locomotive has

51 cells with a capacity of 74 ampere hours. It may be stated that the batteries are seldom discharged more than 60 or 70 per cent of their capacity, and it requires for charging only about one third of the time usually taken for discharging while in operation in the mines. When partially discharged the storage batteries may be fully charged in about one and one-half hours.

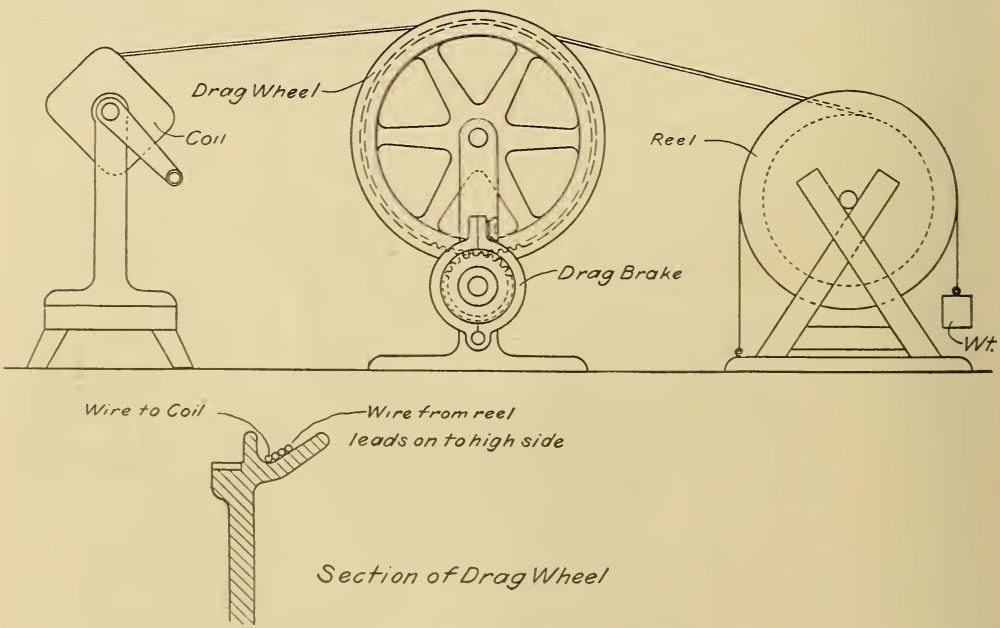
The cost of operation for these storage battery mining locomotives is from one-third to one-half the cost of animal power, and the current required is from one-fourth to one-third kilowatt hour per ton-kilometer capacity. Another advantage of these equipments over the trolley and third-rail mining engine is that no added weight is needed for adhesion as the storage batteries supply all the necessary weight.

The Making and Winding of Magnet Wire

From the earliest period of manufacture of electrical machinery the insulation of armature and field magnet coils has been the weak feature of their construction and the cause of the greatest number of failures. The chief weakness in insulation, which must be avoided, is its liability to destruction from overheating, and in certain classes of machinery, subject to frequent and excessive overloads, even for short periods, the serviceable life of the windings where poor insulation is used may be but a matter of a few months.

Many efforts have been made to devise an insulation for the wire used in this apparatus which would not be so readily affected or destroyed by the necessary heat rise. While this has been accomplished in a measure by the use of special material, generally asbestos, the results have not been satisfactory owing to the bulkiness of the product, and it has been found that the amount of space necessary in proportion to the actual allowable space practically prohibits its use. After experiments extending over a number of years a kind of insulation has been produced, called Deltabeston, in which all of these defects are said to have been eliminated As far as the temperature rise goes, it is practically indestructible, while at the same time the thickness of the insulation compares very favorably with that of ordinary double cotton insulation.

Deltabeston wire is insulated with pure asbestos which has been treated in such a manner that its insulating properties are exceptionally good. At the same time its wonderful resistance to heat renders it absolutely indestructible as far as any temperature rise to which it may be subjected



METHOD OF WINDING MAGNET WIRE

in commercial service is concerned. The following comparison of the heat resisting properties of cotton covered and Deltabeston wire will be of interest.

Investigation has shown that at a temperature of about 147° C. cotton covered wire will in time char to an extent that will break down its insulation. It was further ascertained that at 199° C. cotton covered wire began to smoke in 20 seconds. At 239° C. it was distinctly discolored in 50 seconds and complete carbonization had taken place at 245° C. in two minutes and 15 seconds. These temperatures are of course excessive, yet they go to show how short a space of time is necessary to ruin the field or armature windings on a railway motor, subjected as they frequently are to enormous overloads.

Deltabeston wire tested under identically the same conditions, in fact subjected to icentically the same volume of current, is absolutely unaffected. An interesting comparative test of the properties of the two wires is shown by coupling two pieces together and subjecting them to the same current, resulting in the complete destruction of the cotton insulation while not in the least affecting the Deltabeston wire, which may be further increased in temperature to a dull red heat without its insulation being destroyed. Thus, the only limit to the temperature at which this wire may be run is the oxidization of the copper itself, which will gradually occur if the coil is run continuously at a temperature of over 250° C.

In the winding of magnet coils with this wire the ordinary methods of clamping in order to secure tension do not give satisfactory results. A method recommended is to coil the wire three or more times about the periphery of a geared wheel, the surface of which is higher on one side than on the other, as shown in the cut. Special pains should be taken to feed the wire from the reel on to the high side and draw it off the wheel from the low side.

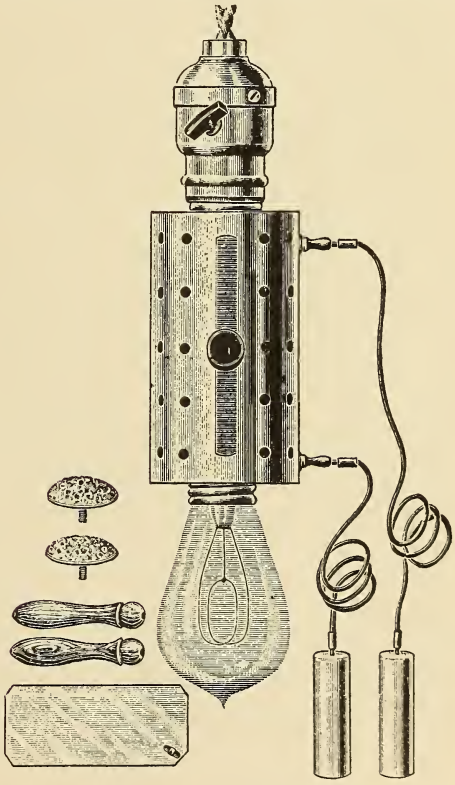
Notice to Chicago Subscribers

Don't fail to give us your new street number. (See notice and form in the Advertising section). This is very important in order that you may not miss any numbers due to their being sent to the old address.

Physician's Current Transformer

Electric current for medical purposes must of course be less powerful than the ordinary lighting current; that is, the voltage must be less. A simple little transformer for reducing the voltage by means of resistance inserted between the electrodes, which come in contact with the body, and the source of current is shown in the diagram, and is known as the White Cross transformer.

One wire from the 110-volt lighting circuit leads to a fine resistance wire wound on a porcelain tube contained within the



THE WHITE CROSS TRANSFORMER

cylindrical casing, from there a wire leads to one electrode. From the other electrode a wire passes to the incandescent lamp and then back to the other side of the 110-volt circuit.

By moving the little button seen on the front of the casing, up and down, the current passing through the body may be regulated by very fine gradations.

The device will give from one to twenty-five milliamperes of current.

Handwriting Duplicated by Wire

There is an extremely interesting device which has been used to a limited extent for ten or fifteen years which comparatively few people have ever seen and fewer still can explain when they do see it in operation. This instrument is the telautograph, a delicate electrical mechanism which will infallibly reproduce your own handwriting at a station as far distant from the sending station, where you are writing, as the wires of the system may reach.

You sit down to the instrument, take up the ordinary pencil attached to it, write the message on the paper pad, and instantly slender metal fingers will begin to work up and down like a jumping jack, apparently with random motions, and the message will be transmitted, letter for letter, and an exact copy of the words and handwriting will be recorded by the metal fingers at the receiving pad as instantaneously as the click of a tetegraph instrument flies from the sending to the receiving instrument. The distance does not matter. The writing at the other end will be recorded wherever the wires can be carried.

The sending pencil is attached by light rods to two lever arms which carry contact rollers at their ends. These rollers bear upon the surfaces of two current carrying rheostats which affect the strength of the current flowing out over the line.

When the pencil is moved, as in writing, the positions of the rollers upon the rheostats are changed and currents of varying strength go out upon the line wires.

At the receiver these currents pass through two light, vertically movable coils, suspended in magnetic fields, and the coils move up or down against the pull of retractile springs according to the strengths of the line currents. The motions of the coils are communicated to levers similar to those at the transmitter. At the junction of the levers is mounted the receiving pen, which by the motions of the coils, is caused to duplicate the motions of the sending pencil.

Ink is supplied to the pen automatically, and when not in use, the pen rests in the ink, preventing clogging and insuring an ample supply at all times.

Paper for use in the instrument is supplied from rolls five inches wide containing approximately fifty yards, and is moved forward as required by automatic shifters.

Perhaps the most interesting and useful application of the telautograph at the present time is in conjunction with the telephone system in a large hotel. The accompanying picture shows such an installation in the Hotel Astor in New York. Another modern hotel which will have such an equipment is the new Blackstone in Chicago, and following is a brief description of how this "long arm" system of writing will aid in giving good service to its future guests.

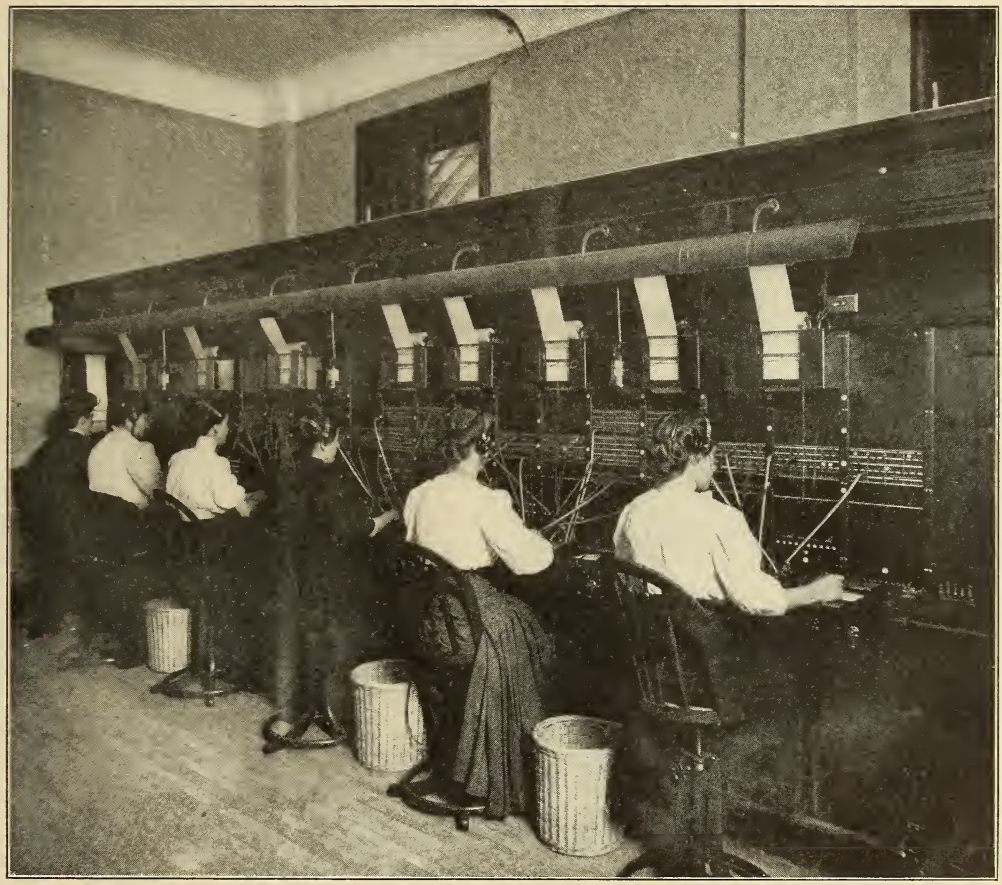
The general scheme of this system includes telephones in every room by means of which guests make known any and all of their wants to the telephone switchboard operator, who in turn is provided with telautograph equipment enabling her to immediately connect with and write to the proper department for information or execution of the request according to its nature. In this way a great deal of the business of the hotel is centralized at the telephone switchboard where each operator makes a permanent record of all the business she handles, whether it originates from a guest in his room, or from some department of the hotel, or from parties calling over the telephone from points outside of the hotel.

There are five "positions" at the switchboard, each position accommodating one operator and containing in addition to the usual telephone equipment, a telautograph transmitter and a pilot receiver and keys enabling the operator to write over any line she selects. Certain of the positions have additional receivers to enable the operator to receive written answers on some lines. The switchboard is what is known as the multiple type, that is, all jacks or telephone connections appear in multiple in each position, so that an operator at any position can supply connection through her mutliple jack to any telephone connected to the switchboard. For convenience the five positions are designated "A," "B," "C," "D," and "E," respectively, and the work of the switchboard is divided among the five positions, by distributing the answering jacks as follows:

"A" and "B" handle the incoming trunk lines and these two positions are equipped

with telautograph receivers for "Information" service between the switchboard and information clerk in the front office in addition to their pilot receivers which all positions have. "C" handles the house business telephones, that is, all the telephones not in the guest rooms, and also a proportional part of the room telephones. This position is equipped with a telautograph her position sign ("A" or "B" or "C," etc.), also to write the time on each message, except on "Information" messages, where only the position initial is required. This is necessary in fixing responsibility in case of errors or delays.

Taking up as an illustration the information service: Practically all of this service consists of incoming telephone calls on the



COMBINED TELAUTOGRAPH AND TELEPHONE SWITCHBOARD IN THE HOTEL ASTOR

receiver on the line connecting the manager's office with the switchboard and a receiver on the departure service line, in addition to its pilot receiver. "D" and "E" handle the remaining room telephones, which are divided between them, and a telautograph receiver on the announcing line to the front clerk is located between these two positions for the use of both of them in announcing callers to guests in their rooms. Each operator is required to initial every telautograph message with trunk lines to the "A" and "B" positions from outside parties wishing to talk to guests. The room number of the guest asked for, or his whereabouts, or whether such a party is registered at the hotel, is the information which the operator requires before she can complete the call, and the information clerks who have access to the guest index book are called on to furnish this information. Prompt and accurate information service is necessary to the good reputation of the hotel, and without it, a guest is like a

needle in a hay stack. The exact method of handling this service is as follows: Suppose "A" position picks up a party on one of her trunk lines calling for Mr. A. C. Brown. She connects her telautograph transmitter to the information clerk line and writes, "A. C. Brown—A". The clerk receiving the message looks up the name, and if he finds A. C. Brown registered and ready to receive calls, he connects his transmitter to the receiver on which the inquiry is recorded and writes "362." In the meantime the operator at "A" position has requested the party calling to "wait a minute," and while the information clerk is looking up the name, the operator attends to other calls or business requiring her attention, and when "362" appears on her information receiver under the name "A. C. Brown," she completes the connection between the party calling on the trunk line and room 362. Occasions may arise requiring any of the positions to write to the information clerk, in which case the position initial on the messages enables the "A" or "B" operator who receives the answer on the receiver before her to notify "D" or "E" position according to the initial. An operator handling an information call may find that the room does not answer when she completes the connection, in which case she offers to "page" the guest, or take a message to be left in his mail box. The procedure in this case is as follows:

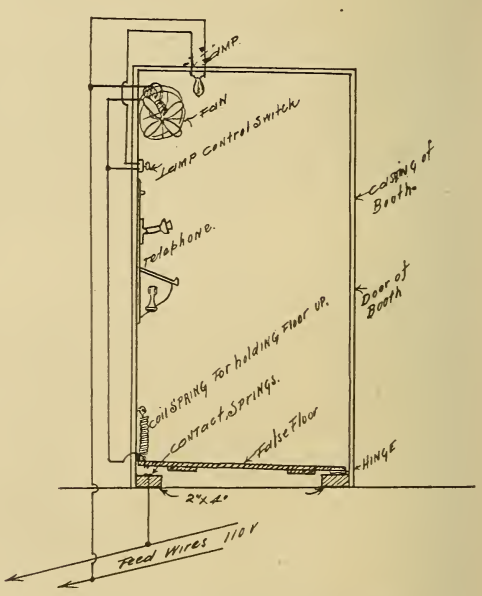
An outside party calling over the telephone for a guest who is found not to be in his room, desires to have the guest located if anywhere in the hotel. The party either agrees to hold the wire while the guest is being paged, or asks to have the guest call him at a certain telephone number. In either case the operator connects her telautograph transmitter to the paging line and writes, "Mr. A. C. Brown, Mr. Smith is waiting to talk to you on telephone No. 2568." She uses the number of the trunk line on which Mr. Smith is waiting if he is holding the wire, or the telephone number Mr. Smith gives her, if he does not want to hold the wire. This paging message appears at the front clerk, who tears it off the telautograph receiver and calls a page to execute it. If Mr. Brown is not found, or a message is simply left to be delivered, Mr. Smith is notified, and the message is properly stamped by the front clerk and left in Mr. Brown's mail box.

In much the same manner the telautograph is applied to a score of other purposes such as giving kitchen, bar and cigar orders, hall boy service, departure service and room changes, porter, cashier and all kinds of inter-department service in the hotel. And the great value of the system is that everything is "down in writing."

Wiring Telephone Booth Fan

One of the readers of Popular Electricity sends the accompanying drawing of a plan by which he wires telephone booths, using the type of telephone booth fan described in the June issue. He says:

"It is for practically the same purpose as your article treats except that there is a



WIRING TELEPHONE BOOTH FAN

false floor placed in the booth, with hinges near the door, so that when the floor is depressed by being stepped upon it closes the circuit starting the fan and lighting the lamp, which both cease to operate when party leaves the booth.

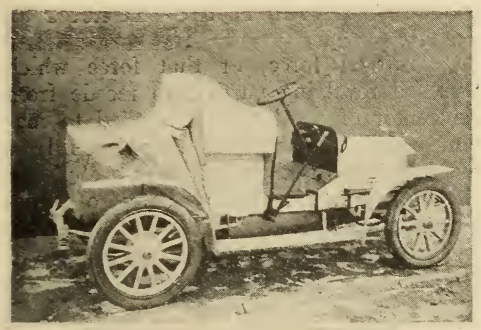
"The lamp is provided with separate switch to act independently of the floor, when the latter is pressed, to be turned off during daylight.

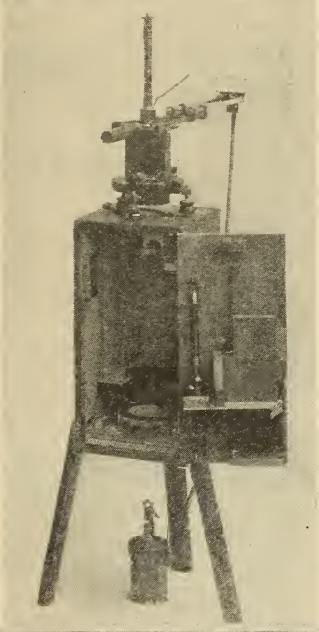
"This system does away with unnecessary wear on the fan and greatly reduces the expense of current."

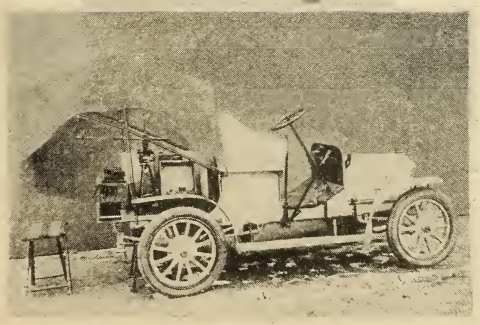
The Testing of Electric Cables

By DR. ALFRED GRADENWITZ

The cable system of a light and power company in any large city is a copper network covering an area of perhaps scores of square miles. In a system so vast there are, in spite of the utmost precautions, weak points where there is a tendency for the insulation to break down and allow the current to escape. Consequently the system needs constant watching and testing that precautions may be taken to prevent breakdowns, also to see that new work is properly constructed. These tests involve the use of more or less delicate apparatus for determining the insulating properties, electric capacity, resistance, etc., of the cables.

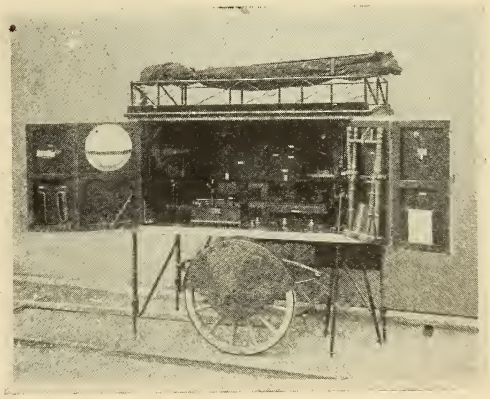






In making the tests portable testing outfits are often necessary, and in the design and fitting out of portable testing equipments the Germans have shown both skill and ingenuity.

One German manufacturer has developed a special style of automobile to serve as a traveling testing station. The cars either comprise an enclosed case accommodating the operator with his apparatus, or, in its place, a simple folding tent. Pictures of the latter type are here shown, in traveling and working order.



The whole testing apparatus is so arranged in this car as to be readily erected and rapidly and safely unmounted. The rear extension of the car comprises all the parts required for the testing of electric cables. Being readily detached, it is replaced either by a double seat or by a box for transporting tools, materials, etc. Thus modified, the automobile proves of much help in transporting raw materials.

The apparatus, arranged in working order, comprises all the instruments necessary for measuring the insulation, capacity and resistance, and ascertaining defects in the circuit.

For the purpose of making similar tests a push cart fully equipped with instruments has been devised by the same company, also a portable tripod case and mirror galvanometer.

Novel German Street Cleaner

Berlin can boast of being the cleanest city that exists. This is the opinion of the many thousands of foreigners visiting it every year. It is also a fact that German municipal institutions in general are of the highest class. This is due to the method of using the latest inventions and improvements made for the welfare of a city.

NOVEL GERMAN STREET CLEANER

Besides a large army of street sweepers and many mechanical brush sweepers, some years ago machines were installed with a water tank and a rubber broom which sprinkles and washes the pavement at the same time. This is indeed a great advantage over any other system, as the street is dried off immediately after sprinkling, while the ordinary water-cart leaves the ground wet and muddy.

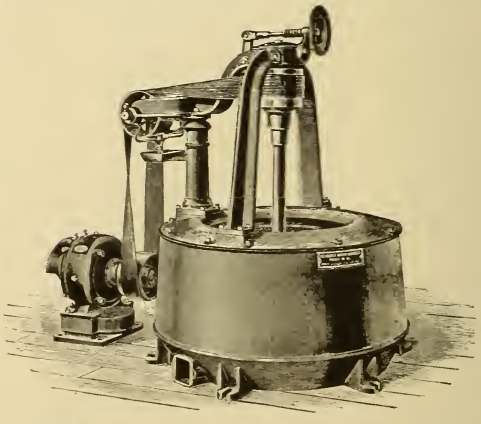
Such washing machines were originally drawn by horses, but recently a motor-driven car was introduced. This new electric sprinkler has a greater capacity, the speed is higher, and the whole vehicle requires less room, which permits it easily to be turned and pass through narrow streets.

As a result of the introduction of this machine, the society of German team owners has asked the authorities to prohibit sprinkling asphalt streets by the ordinary carts, and to enforce the use of these washing machines exclusively.

Motor Driven Hydro-Extractor

Centrifugal force, or that force which causes a revolving particle to recede from the center of revolution is applied to machines called extractors, largely used in laundries, mills, chemical works, etc. An extractor, or more properly a hydro-extractor, used in a laundry for example, consists of a rapidly revolving basket-like cylinder inside of a cylindrical casing. The wet clothes are placed in the basket and as the latter revolves the water is drawn out by the centrifugal force, passes through the basket and is caught in the casing from which it runs off through a suitable outlet. The clothes as they come from the extractor are almost dry.

After exhaustive tests the electric motor has been found to be the most effective for the operation of these machines, the principal advantage being the rapidity with which the basket may be made to attain full speed and this saves time as a great many basketfuls are run through in an hour.



MOTOR DRIVEN HYDRO-EXTRACTOR

A self balancing hydro-extractor is shown in the illustration. The belt provides a flexible connection between the motor and the shaft of the extractor and the vibration of the latter does not affect the motor.

Talks With The Judge

The "Judge," by the way, was not a judge at all, but an advertising man. He was, moreover, one of those men whom we so often hear to remark: "I wish that when I was going to school I had studied electricity. The subject has always interested me, but these are so many things about it that I can't understand that I guess I might as well quit trying to learn at this late date." But in spite of his avowed inability to ever be able to grasp the fundamentals of the subject it was only necessary for me to mention electricity to turn him into an animated question box.

He always prefaced his remarks with: "What I can't understand is this," or "I wish somebody would tell me," and then he was off on anything from street cars to the latest type of electric vacuum cleaners. A talk with the Judge on electricity was always interesting to me because to answer his questions in "Plain English" was a constant mental brushing up, and the questions were, at the same time so indicative of the kind of information that the public at large stands in need of concerning the great force which is so rapidly attaining the front rank in all the world's activities.

"I wish somebody would tell me about a trolley wire," said the Judge. "I thought I knew what it was and how it worked. But something happened the other morning that stumped me. I was on a car and we came along to a place where the trolley wire had been broken and wasn't spliced yet. Somebody had fastened it over out of danger, but there it was, a clean break in the line. Well, do you know what the motorman did? He simply put on full speed, jumped the gap and after we had grabbed the wire on the other side we went on again as fine as you please. Now I always thought that the trolley wire brought current from the power house to the car. I had also been told that the current must have a continuous conductor to flow in. Now tell me how the current got across that gap so as to run the car after it had coasted over to the other side."

"Judge," said I, "Did you ever notice that on the poles carrying the trolley wire or else on poles near by there is a heavy cable running parallel to the trolley wire. Well, there usually is, and if it is not there it is in some underground conduit out of sight. This cable is called a "feeder" and is considerably larger than the trolley wire. Its function is to bring current from the power house and distribute it to the trolley wire at numerous points along the line. This feeder, being large, carries current more easily on account of its low resistance and it helps to keep the voltage up to the full 500 or 550 volts at all points on the line. Every few blocks a tap from this feeder leads over to the trolley wire, and consequently you might cut the trolley wire in two between each of these taps, making it into a number of isolated sections and still the car would get current from the feeder taps to run it.

"Therefore, when you came to the break in the trolley and jumped across the gap you found a current supply awaiting you on the other side which had come into the trolley wire beyond the break through the taps from the feeder wire farther along."

"That straightens out the trolley wire business," said the Judge, "but there is something about the third rail that I can't understand. They call it the "deadly third rail," but as far as I can see it is about as deadly as an ordinary turnpike.

"Last week I was riding on an elevated train and we came to a blockade. A lot of the passengers became tired of waiting and got out of the cars to walk along the ties to the next station so as to get down and take the surface cars.

"Well, sir, do you know, I watched those people for quite a time and I noticed at least a half dozen women step onto that rail and never know the difference.

"Why weren't they electrocuted?"

"I'll try and make that plain, too, Judge," said I.

"On the third rail system current from the power house is carried along the third rail, which is insulated from the elevated structure. It is collected by the little shoes hung from the motor car, passes through the car motor and out through the wheels to the track rails, thence back to the power house.

"The third rail is therefore no more or less than a great big trolley wire laid along side of the track. To get a shock from it you would have to have one foot on the

third rail and the other on the track rail at the same time. In the same manner it would be necessary for you, in order to get a shock from the trolley wire, to have one foot on the trolley wire and the other on the track rail or ground.

"In either case you would be placed in the position of the car motor and would receive current through your body.

"Evidently the women didn't touch both third rail and track rail at the same time; which, by the way, from their relative positions is not the easiest thing in the world to do.

"Moreover, if they had done so it would not necessarily have meant death. The difference in pressure between the third and track rails is from 500 to 550 volts, by no means a deadly pressure, especially since the shoes and stockings offer a partial insulation. The chief danger comes in being knocked down by the shock and lying across the two rails, unconscious. Then if help does not arrive soon death may result from burning."

Handling Lumber by Electricity

This picture shows in operation a motor driven crane used in handling lumber and heavy timbers in one of Chicago's lumber yards. Three of these equipments are used in this one yard.

Control of the apparatus is centered in the motor house built around the vertical mast some distance from the ground. This house contains a 15 horse-power motor, the necessary starting and stopping devices, and a wire rope drum for raising and lowering the block and for moving the load back and forth along the extension arm. At the right

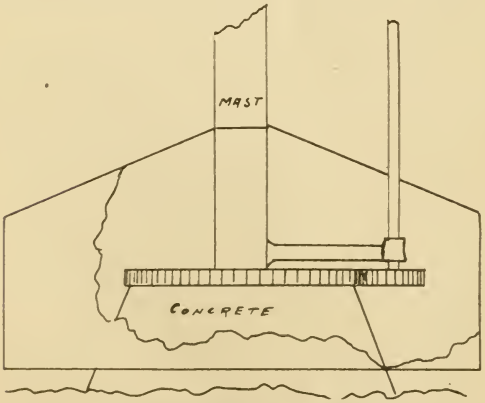


FIG. 1. ARRANGEMENT OF CRANE BASE

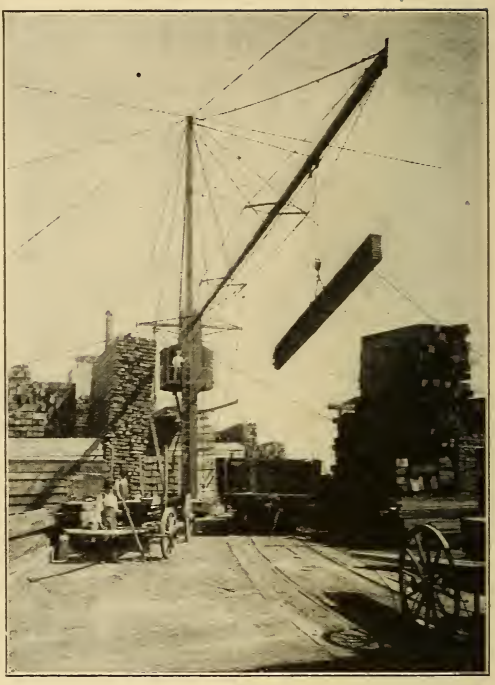


FIG. 2. CRANE IN OPERATION

of the mast may be seen a shaft running from the motor house down into the base of the structure. The lower end of the shaft runs through a bearing on the base, and on its lower end has a small toothed wheel meshing into the circumference of a large fixed wheel. As the small wheel turns, the crane travels in a circle on the center mast as a base, the arrangement being shown in Fig. 1. The

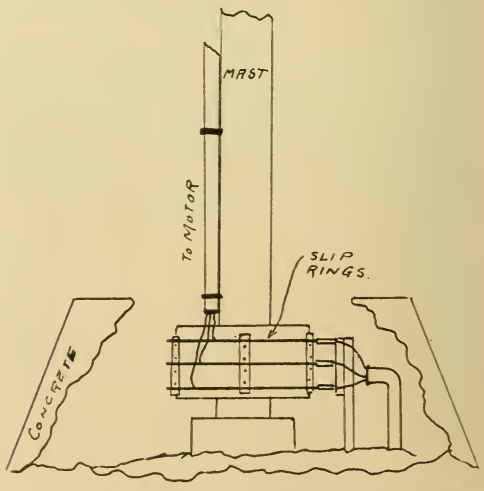


FIG. 3. COMMUTATOR TAKES CURRENT FROM UNDERGROUND WIRES

wagon in Fig. 2 has just received two crane loads and a third is about to be swung over and lowered.

The electric wires are brought to the structure in conduit run underground. Fig. 3 shows these wires carried to slip rings at the base and then to the motor.

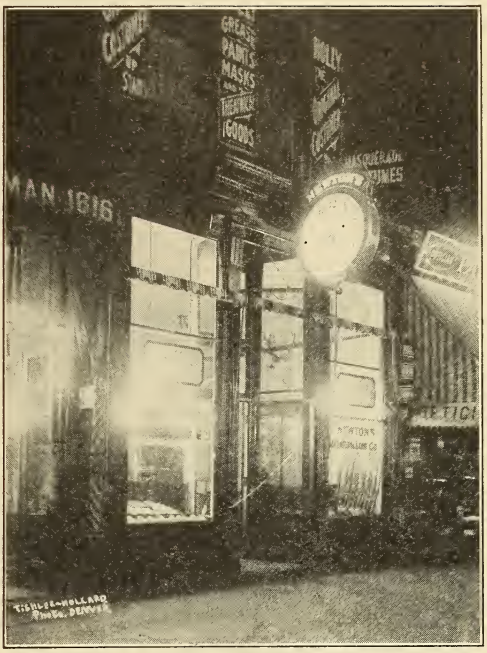
By the use of this device lumber is handled easily and quickly, requiring fewer men, and piles are built higher, economizing space.

Electric Advertising Clock

In front of one of Denver's prominent business places is a unique clock which is illuminated and operated by electricity and which by a simple electric mechanism is made to ring a bell in the doorway of the store every minute. Since the photograph here reproduced was taken, the gas jets placed in the window for advertising purposes have been replaced by the best of all window illuminants —tungsten lamps.

This is an example of the right kind of central station solicitation. The business of the store keeper made a clock the best sign for his purpose. The lighting company's expert showed him how he could illuminate the clock by electricity, and at very little expense put in the bell to attract still more attention. With these new features adding to the appearance of his store front the proprietor could no longer permit his windows to be lighted with dismal flickering gas jets —the tungstens followed.

The result is a permanent customer for the lighting company, who is intensely pleased with the transformation electricity has made in the appearance of his store.



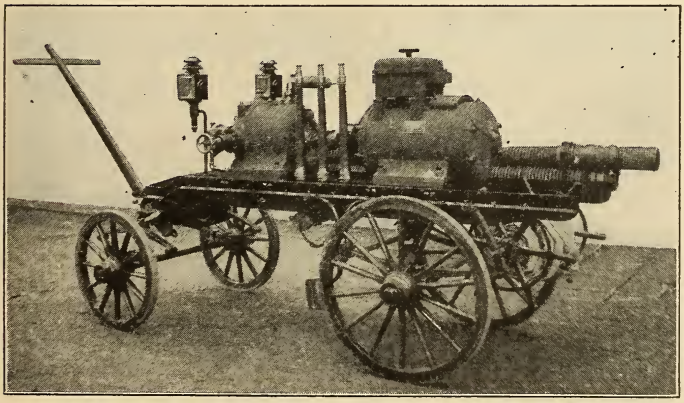
ELECTRIC ADVERTISING CLOCK

Novel Swiss Fire Pump

This fire pump wouldn't be of much use in a city of sky scrapers but for villages and hamlets, around factories and industrial plants, etc., it can be used to advantage wherever it is possible to connect with live electric wires, for the pump is driven by electric power.

The motor drives a multiple, high pressure centrifugal pump and together with hose-drum and nozzles is mounted on a light truck. The whole outfit is easily portable and will discharge about 130 gallons of water a minute under a pressure of 100 pounds to the square inch.

In a large chemical works in Switzerland one of these pumps was given a very severe test and worked for 72 hours at a stretch without a stop, demonstrating the practicability of using electricity for the operation of this class of apparatus.

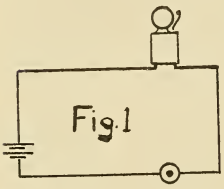


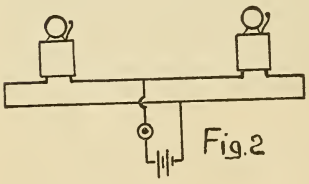
NOVEL SWISS FIRE PUMP

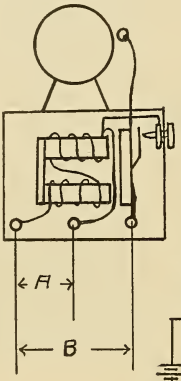
Electric Bell Wiring

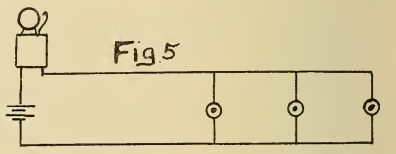
Many of the readers of Popular Electricity have asked for varied information on bell and signal wiring. These questions have been answered from time to time through the Question and Answer Department, but in order to present the information in more readily available form the following description of various combinations is given.

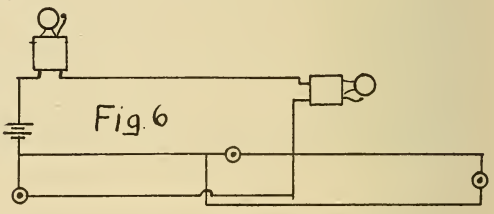
What is commonly known as "annunciator wire," No. 16 or 18 B. & S. copper wire wound with two layers of cotton and treated with paraffine is least expensive for dry

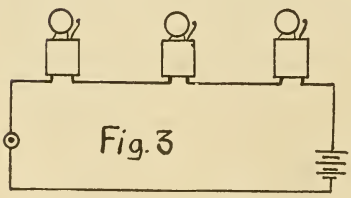


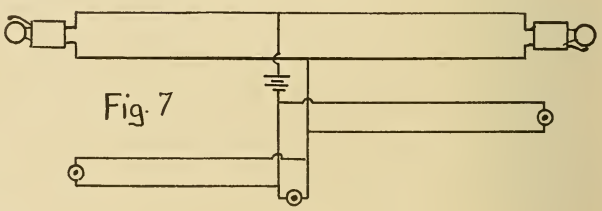


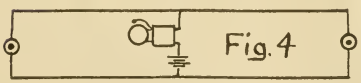


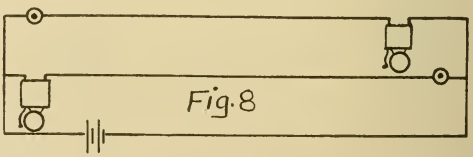


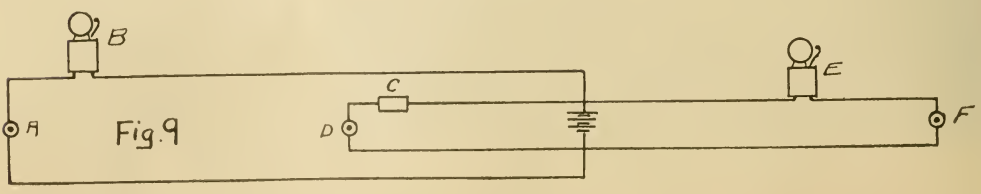












places. This wire is, however, not thoroughly moisture proof, and consequently rubber covered wire is more satisfactory, and by signal service companies operating local fire and other alarm systems is almost universally used, No. 16 being preferred on account of lower resistance and greater mechanical strength.

Underwriters' requirements regarding electric light and signal wires are as follows:

"Signaling wires and electric light or power wires may be run in the same shaft, provided that one of these classes of wires is run in non-combustible tubing, or provided that when run otherwise these two classes of wires shall be separated from each other by at least two inches.

"In no case shall signaling wires be run in same tube with electric light or power wires.

"Electric gas lighting must not be used on the same fixture with the electric light."

Below are various diagrams of circuits and bells.

Fig. 1 shows one bell operated by one push button.

Fig. 2 shows two bells in parallel operated by a single push button.

Fig. 3 provides for the operation of three bells in series from one button. When bells are operated in series all but one should be single stroke so that the breaking of the circuit will be done by only one bell.

One bell rung from either of two push buttons is shown in Fig. 4, while Fig. 5 shows one bell operated from any one of three points.

In Fig. 6 two bells in series may be rung from three different points, while Fig. 7 provides for the same thing with the bells in parallel.

Fig. 8 is a three-wire return bell and call circuit.

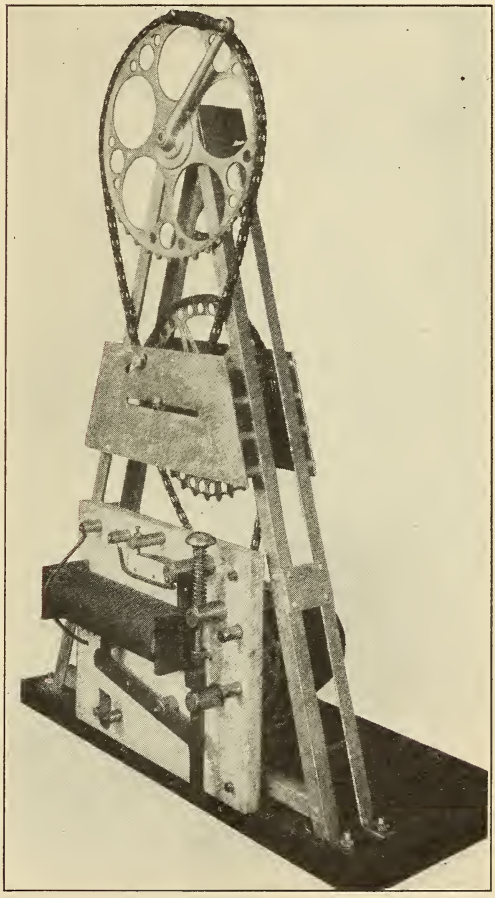
Fig. 9 shows how a small house may be wired, (F) being the back door push button, (E) the back boor bell, (D) the dining table push button, (C) the kitchen buzzer, (A) the front door push button, and (B) the front door bell.

Fig. 10 shows the arrangement and windings of a bell which may be operated either as a single stroke by connecting to terminals (A) or as a vibrating bell by connecting to terminals (B).

John Hollingshead was the first man to use electric lights in London. In 1878 he installed six arc lamps at the old Gaiety.

Machine for Exploding Blasts

In order to obtain the accumulative effect of a number of charges in blasting it is necessary that the charges be all exploded at exactly the same instant, in which case there is one grand upheaval, far more effective than intermittent explosions, even if they are but a fraction of a second apart. The machine shown in the picture is designed for this purpose and will explode over one hundred charges simultaneously.



MACHINE FOR EXPLODING BLASTS

"Oh, I love to figure out such problems during spare moments," said Mr. Forée Bain, patent expert and engineer, of Chicago, who designed the machine. "I have never taken out a patent on it but occasionally my friends the contractors and quarrymen want such a machine, and I have it made up. It does the business, and in

one case they were able to make a reduction of 30 per cent in the amount of explosive used, owing to the simultaneous firing of the charges."

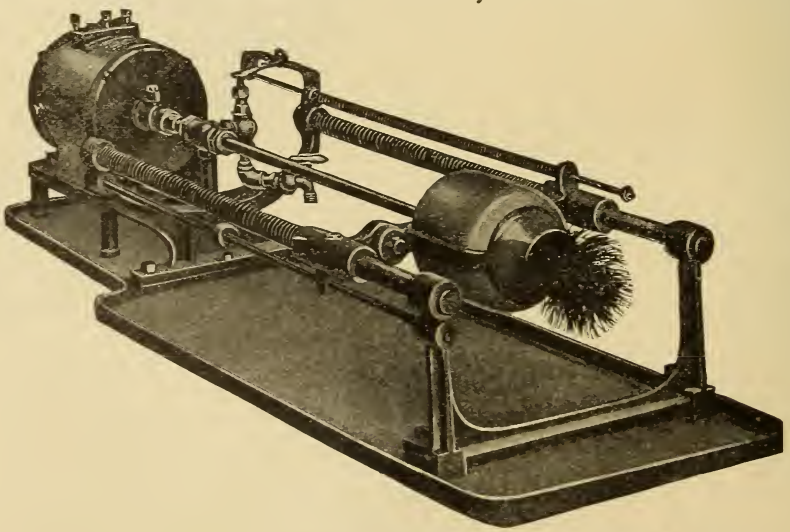
The machine is simple but effective. A small dynamo mounted on the base and just visible back of the frame is driven with a crank by means of the sprocket wheels and chains. This furnishes the current for melting the fuses which set off the blasts. In starting up the dynamo by hand it would be impossible to bring the current up to full strength at once, as that depends upon the speed. So it would also be impossible to explode all the fuses at the same instant, for in order to do this a very heavy current wave must be thrown on them suddenly. To accomplish this end the electro-magnetic switch shown on the front of the marble slab is added.

Current from the dynamo first passes around the coil of the electromagnet, which has an iron core. As the current around the coil becomes stronger, while the dynamo is being speeded up, the magnetic strength of the iron core increases and when the dynamo is up to full speed and the current strong enough to explode all the fuses at once, the iron core is energized sufficiently to pull the vertical armature over. This releases a catch on the vertical shaft seen at the right of the coil, and the spring pulls the shaft up with a jerk. Beneath the coil is a switch which is operated by the shaft, and this switch when thrown to the lower contact suddenly throws the whole current of the dynamo onto the fuse circuit. The heavy surge of current, accentuated by what electricians call the "inductive kick" of the coil itself, melts all the fuses at a flash.

Electric Bottle Washer

Owners of small bottling establishments were in the past confronted by a serious problem in the cleansing of the bottles. Large power washers were so costly and expensive to operate as to be almost prohibitive for the small bottler. Hand washing, too, was a tedious process, and a foot power machine was almost as unsatisfactory, for one man could not keep at the washing all day long with these methods. Yet no other power was then thought available, so the make-shift methods continued.

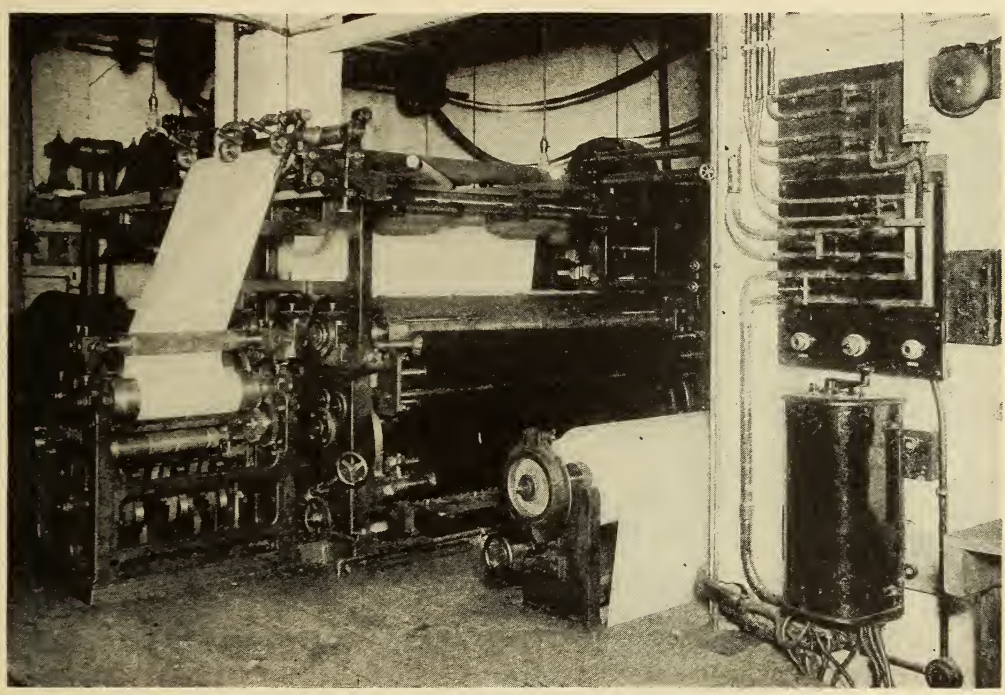
Now, however, since the small motor has been developed to a degree which makes it applicable to almost any mechanical process the small bottle washer is found in moderate sized establishments to be operated by electricity. One of these machines is shown in the picture and works as satisfactorily in its limited field as does the big power driven washer in large establishments. The motor is entirely enclosed and water-proof and consumes only $\frac{1}{6}$ horse-power.



ELECTRIC BOTTLE WASHER

Control of Large Printing Presses

The great presses which print and fold in a few hours hundreds of thousands of copies of our metropolitan dailies are operated by electric motors for several reasons. In the first place the control of this, perhaps the most complicated piece of mechanism in existence, may be accomplished with an accuracy and certainty not to be approached by any other method of drive. It provides means for the protection of the men working about the press and is also economical of floor space, which is an important item where rents are high.



MOTOR CONTROL FOR A DUPLEX ROTARY PRESS

In the ordinary web press the motor equipment consists of a large, variable speed motor for driving the press on producing speeds, also a small motor with a special clutch for driving the press slowly in threading in paper, but which is automatically relieved by the large motor when the real work begins.

In order to control the action of these motors wonderfully sensitive electric controllers are employed, which may be actuated by push buttons located at any number of stations desired, about the press room and the great press itself.

In one type of controlling apparatus each station is provided with four push buttons which are used for accelerating, decelerating, stopping and putting in safety. When the accelerating button is pushed the motor is gradually and automatically brought up to speed. This process may be interrupted, however, by releasing the button at any stage, and the motor will continue to run at the speed attained when the button was released.

If it is desired to decrease the speed, as is often the case when nearing the end of a roll of paper to avoid tearing, the decelerating button may be pushed, and the reverse process takes place.

The press may be stopped promptly at any time by simply pressing the stop button at any station; in which case the controller automatically returns to the off position.

To avoid accident due to starting the press before everything is in readiness, and as a safeguard to the pressmen who may be

making adjustments, each station is equipped with a safety button which is so connected that it is impossible to start the press unless all of these buttons are placed in the "run" position.

The controller described above is known as the "master" type. There are other types known as drum controllers (something like street car controllers) which are only applicable to single station control, although they are provided with push buttons and auxiliary circuits which may be used to stop the press instantly in case of accident.

Some of the drum type controllers also work in conjunction with push button control systems marked "start," "run," "safe" and "stop," and any number of these stations may be included in the equipment. Such a one is shown in the illustration of a large duplex rotary press of the Journal of Commerce, New York City. The drum controller is here seen at the right, and above it are the switches and fuses for the various circuits.

Electric Fire "Whistle"

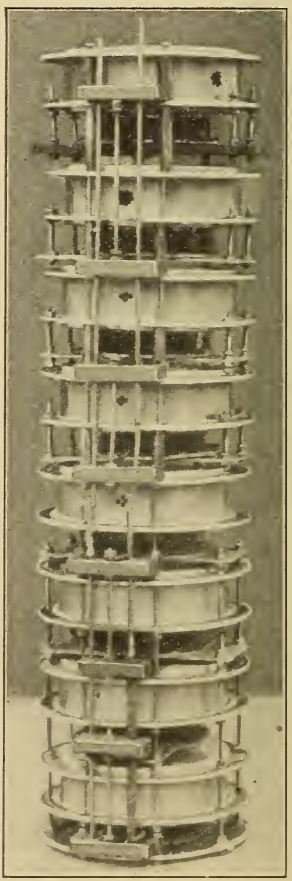
Captain Obed De Champ of the Everett, Mass., fire department has saved that city a considerable sum of money by an ingenious invention which cost only $10.00. It is an electric fire "whistle," which works somewhat upon the plan of the telephone receiver. Diaphragms of considerable size are caused to vibrate rapidly by the use of small induction coils. The volume of sound may be increased or decreased by adding to or taking from the number of sections which form the whistle. The whistle prepared for the city of Everett has diaphragms about ten inches in diameter and is made up of eight sections, as shown in the photograph. Each section contains a diaphragm and is a complete whistle in itself, only giving less volume than the eight sections combined.

It is the first fire whistle of its kind in the country. When in position the working parts are encased in a cylindrical galvanized iron covering, which concentrates the volume of sound at the opening in the top.

This electric device, costing only $10.00, will do the work of the ordinary compressed air whistle, which with its compressed air tanks costs about $2500.

Hints About Soldering

A subscriber to Popular Electricity offers the following hints which are helpful in soldering for electrical work. To keep iron clean while soldering, dissolve one part



ELECTRIC FIRE "WHISTLE"

of sal-ammoniac in four parts of water, and heat the iron and give it a quick dip in the solution. If the least bit of solder is placed on the iron, it will spread farther and farther over the surface.

In soldering electrical connections the following flux is excellent: Take six parts of vaseline and one part of chloride of zinc. Heat the vaseline and pour in the chloride of zinc and stir till cold to keep the heavier parts from settling.

Seven million dollars have been appropriated for the electrification of the Italian railways.

Beautiful Example of Ballroom Lighting

No example of modern electrical illumination is more attractive or more completely fulfills the practical and artistic requirements of the case in hand than that of the new ballroom of the South Shore Country Club in Chicago. The pictures shown herewith, from photographs taken with no other light than the indirect illumination, give but a faint idea of the softness and effectiveness of the perfectly diffused rays.

This club has sixty acres of lake front at Seventy-first Street and has expended nearly a million dollars in improvements. The latest addition to its buildings is a magnificent ballroom, 90 by 140 feet in size, of classic style of architecture. Ionic columns separate a 12-foot promenade on all four sides of the main ballroom, following what is known as the clear story treatment. The main ballroom ceiling is 28 feet, that of the promenade 20 feet. This constitutes practically one auditorium, the promenade being divided from the main ballroom by 30 of the large columns. The room is finished in old ivory and gray; the trimmings of American beauty red, and the architectural features and decorations of this room are conceded to be among the finest of any auditorium of its kind in this country.

The question of the proper illumination of this room was a serious one. Mr. B. F. Winston, chairman of the Buildings and Ground Committee, and Mr. Bode, president of the club, were both abroad early in the year and they investigated the illumination of many auditoriums, both there and in this country. They decided upon indirect illumination; the covering of the light source from range of vision.

The outlets as originally placed for direct lighting proved to be admirably located for the indirect system. There were three at equal distances in the 28-foot center ceiling and one in every 12-foot panel in the ceiling of the promenade. So there were located in the main room three large central chandeliers, each one containing 23 "I-Comfort" lighting units, and single fixtures around the promenade, as shown, each containing one lighting unit. One hundred watt tungsten lamps are used and the results are far beyond the architect's most sanguine expectations. The fixtures are made of composition with bronze metallic finish and are very handsome in design. The cost of all metal work for a direct system of lighting would have approximated $2,000, whereas the indirect system was put in for about half that amount.

All those who enter the ballroom are immediately impressed with the magnificent results obtained and almost their first expression is regarding the beauty of the illumination. During a ball the scene is one of unusual splendor, the colors of the different gowns being brought out with a distinctness that is most surprising. The illumination, while brilliant, is peculiarly aesthetic, and at the same time the perfectly diffused light gives marked eye comfort.

Handling Coal in German Power Plants

As pointed out in a recent lecture by Mr. Datterer, director of the Berlin Electricity Works, the total capacity of the central stations supplying the German capital with electric light and power has increased, from 1902 to 1908, from 62,000 to 154,000 horsepower, the heating surface of their steam boilers having increased from 25,000 to 45,000 cubic meters. In step with this growth, marked improvements have been made in the design of mechanical coaling apparatus. It may be said that the Berlin Electricity Works in most cases is free to choose between waterways and rail, for the coal supply, the latter alternative affording the advantage of allowing of an approximately uniform supply, even in the winter time, when the various plants are put to the highest strain. As, however, the saving in the transport expenses greatly exceeds the additional outlay required for the provision of winter stores, most of the plants of Berlin have preferred transportation by water.

An especially interesting coaling plant has been recently erected for the Rummelsburg central station (near Berlin), where

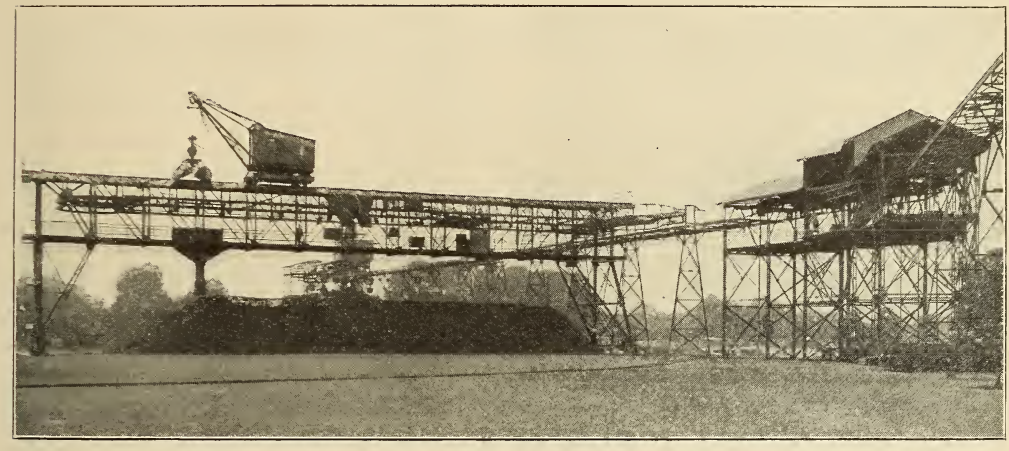


FIG. 1. ELECTRICALLY OPERATED DUMPING BRIDGE

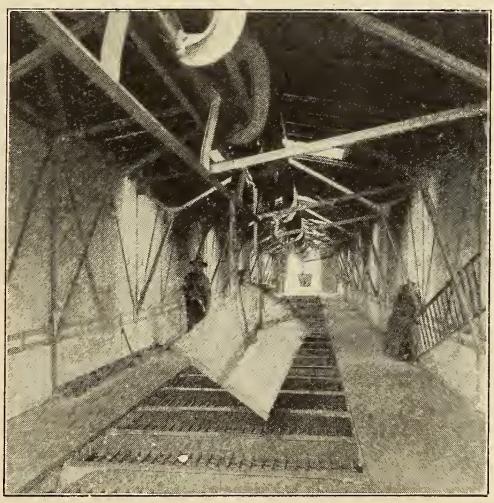


FIG. 2. AUTOMATIC COAL CARRIER IN BOILER HOUSE

wire rope railways are used on an extensive scale.

The ground covered by the coaling plant consists of two parts, the one immediately on the river Spree being used for the storing of coal, and the other mainly for the boiler and engine house, and accessory installations. The storage yard contains an elevated tank of 1,500 tons' capacity, made of iron structure, at the bottom of which there are chutes with locking gates for each boiler, so that the coal may glide down automatically into the hoppers of the mechanical stokers.

One of the distinctive features of the plant is that the wire-rope railway, leading from the banks of the river across the coal

stores to the boiler house, is divided into two self-contained parts. The device chosen for connecting the trucks with the traction cable, therefore, had to be such as to seize cables of different diameters with equal safety, and a patented automatic clutch had to be adopted. This clutch utilizes, for throwing the jaws together, the total weight of the truck body inclusive of its contents and suspension, so that a considerable amount of energy for effecting its closure is available.

The following conditions had to be complied with in designing the coaling plant: Transports with a capacity of 50 tons per hour had to be provided for; (1) from the ship into the boiler house bunkers; (2) from the ship to one of the three store yards; (3) from any one of the store yards to the boiler house or (in the case of a coal fire) to some other store yard; (4) from railway cars into the boiler house or to any one of the store yards, transports by rail being provided for as reserve, in cases of emergency.

A further requirement was that transportation from the river barge to either of the two store yards situated on the Spree and the transfer from the third store yard into the boiler house, should be performed simultaneously. This is why the wire-rope railway was divided into two sections.

The crane (Fig. 3) with inclined runway and stationary winch, provided with an automatic grab bucket of two cubic meters capacity, is used for unloading the coal from the barges. This crane throws the fuel into a bunker whence it is discharged into suspended railway trucks.

The first section of the wire-rope railway leads in a straight line from the bank to one of the angle stations, where the driving gear actuated by a 15 horse power motor, in common with the second section, is located. The filled trucks travel over the dumping bridge (Fig. 1) and are there tilted automatically by striking against an adjustable stop on the bridge, and after being transferred at the driving station onto the emptied truck, return to the loading loop near the crane. Before arriving again at the traction cable, the useful capacity of the filled trucks is ascertained by a self-recording weighing machine. If the coal is to be taken to the store yard near the boiler house, or into the elevated reservoirs, the trucks are transferred at the angle station to the second wire-rope line

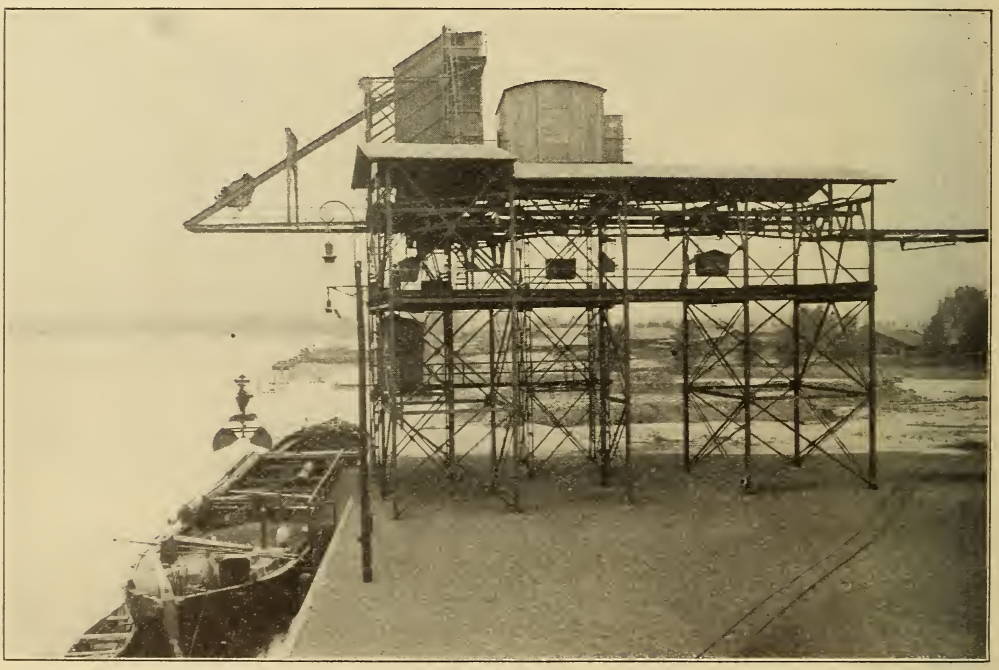


FIG. 3. A MOTOR OPERATED GRAB BUCKET LIFTS THE COAL FROM THE BARGES

in order to be tilted either on the store-yard bridge or at the boiler house (Fig. 2). Any pieces of excessive dimensions are there kept back by a grate and crushed by the workmen entrusted with the superintending and adjusting of the stop. The empty trucks return across the angle station to the river barge.

Rotary cranes traveling on the store yard bridges and covering any point of the yards, are used for taking the coal back from the latter into the wire-rope railway in order to convey it to the boiler house or to some other store yard. These cranes seize the coal by means of grips, and throw it into hoppers in the middle of the bridge, whence it is supplied in a continuous flow to the wire-rope railway trucks which pass continuously

The wire-rope railway trucks have a capacity of 1,500 pounds each, so that 74 trucks per hour have to be run in order to ensure the required output of 50 tons. The trucks, accordingly, follow up one another at intervals of 49 seconds, or about 150 feet apart.

The working costs for conveying the coal from the barges to one of the store yards, or to the boiler house, amount to $0.047 per ton. The total amount of coal to be conveyed from the store yards to the boiler house amounts to about 23,000 tons and has to be dealt with in five months. Working expenses in this case amount to about three-tenths of a cent more per ton.

A Glimpse into the Future

[Time, 2500 A. D. Place, forward deck of airship "Queen of the Air" en route from New York to Chicago. Speakers, Mr. A. D. Rocks of Chicago and Mr. J. K. Brocks of New York.]

Mr. R.—So this is your first trip to Chicago? That seems strange when you think that the time by airship has been reduced to forty minutes.

Mr. B.—Yes, I know I should have made the trip before, but I have been so busy with my building operations lately that I have not had time.

Mr. R.—What are you putting up now?

Mr. B.—Oh, just a little building 125 stories high.

Mr. R.—Is that so? There's a company in Chicago that is erecting one that is to be the tallest in the world, 310 stories high. They had a hard fight to keep the city council from passing an ordinance limiting the height of buildings to 300 stories. I understand that it took ten millions to get the aldermen to see things their way.

Mr. B.—I expect to go about quite a little in Chicago. How is your suburban transportation?

Mr. R.—Very unreliable out west of the city where I live. The other day something went wrong with the pneumatic pressure and it took me at least eight minutes to reach the office and I only live thirty miles out. What do you think of that?

Mr. B.—Awful. But just think what it must have been like five or six hundred years ago when people had to rely on those old fashioned trolley cars and railroad trains that crawled along at the rate of thirty or forty miles an hour.

Mr. R.—Say, by the way, did you know that we had just received a wireless despatch to the effect that a great battle has been fought between the German and French armies. The German electrical artillerists, it seems, have wiped out the entire French army of six million men by hurling a bolt of electritity at them by wireless. The entire battle was fought in six minutes.

Mr. B.—Terrible, terrible! But at least the soldiers were all electrocuted instantly so that they did not suffer any pain.

Mr. R.—Excuse me a moment. I'm going to ask the captain to turn on a little liquid air; it's getting so warm here. (Goes forward to speak to captain and returns a moment later.) Say, what do you think! The captain informs me that one of the French aerial men-of-war has succeeded in electrocuting the entire German army by wireless bolt so that now the two nations will have to come to terms by arbitration as neither has any troops left.

Mr. B.—I read a notice in the paper the other day to the effect that a movement is on foot in Europe to unite all the countries on the continent into one nation in order to prevent this fearful waste of life.

Mr. R.—I think it would be a good idea. It will undoubtedly become necessary in

time just as it was found expedient to establish universal free trade when the use of airships became general, as their adoption made it impossible to prevent smuggling.

Mr. B.—Have you heard of the latest moving picture scheme?

Mr. R.—No, what is it?

Mr. B.—Why, one of the New York papers has installed an apparatus to take the place of a bulletin board. If you want to find out what is going on anywhere all you have to do is to stand in front of the canvas and see the leading events of the world take place before your eyes in moving pictures.

Mr. R.—Well, that's great! How is it done?

Mr. B.—Why, simply enough when you come to think of it. All they have to do is to have their correspondents in various parts of the world provided with machines for taking moving pictures and transmit them instantly to New York by wireless. It saves the time of printing the news and you can see an eruption of Vesuvius or a Georgia lynching at the same time it occurs.

Mr. R.—Well, I'll have to take a look at that the next time I'm in New York. It must be very interesting.

Mr. B.—Where are you going to spend the summer this year?

Mr. R.—I'm going to take a trip to Europe.

Mr. B.—Are you contemplating an air voyage?

Mr. R.—No, my wife always gets so terribly airsick that we'll have to take the submarine tube. I don't care for these long pneumatic tube trips myself. It is always a tedious five hours to me. I understand, however, that improvements are being made by which it will be possible shortly to make the trip from New York to Liverpool in two hours and a half. That will be a little more bearable.

Mr. B.—Have you taken the trip over the Alps by airship yet?

Mr. R.—No, we haven't.

Mr. B.—Oh, you must take that trip by all means. The scenery looking down on the snowclad mountains is magnificent; the sunsets rival description.

Mr. R.—Excuse me a moment; I'll call up my wife and ask her to make a note of it. (Takes out a pocket wireless telephone and speaks briefly to Mrs. R. in Chicago.) There, that's settled. She's sure to remember it, she's so fond of scenery.

Mr. B.—Have you noticed by the papers what a lively time they are having in Mars nowadays?

Mr. R.—Yes, I should say. I took a look through one of the big telescopes the other evening and witnessed one of the great land battles between the two nations at war. They seem to be away behind us in the art of warfare; I noticed that they still employ the old fashioned guns and cannons our ancestors used in the Twentieth Century.

Mr. B.—Yes, being in the age of art and philosophy they are naturally behind us in scientific matters. They are taking lessons from the earth, however, and I understand their scientific journals are printing technical accounts of our method of carrying on battles, the articles being sent to them by wireless.

Mr. R.—They resemble the people of Mercury in that respect. The only planet that approaches the earth in scientific development appears to be Venus.

Mr. B.—Yes, I was reading a psychological treatise the other day by a writer of that planet and I could see that they are far ahead of us.

Mr. R.—That's true. If you want the latest scientific information you have to go to Venus for it. Mercury furnishes us with some very good musical compositions, however. My daughter has been getting some very fine ones for the piano lately.

Mr. B.—It's wonderful what the wireless has done for us since we have gotten into communication with the other planets, isn't it?

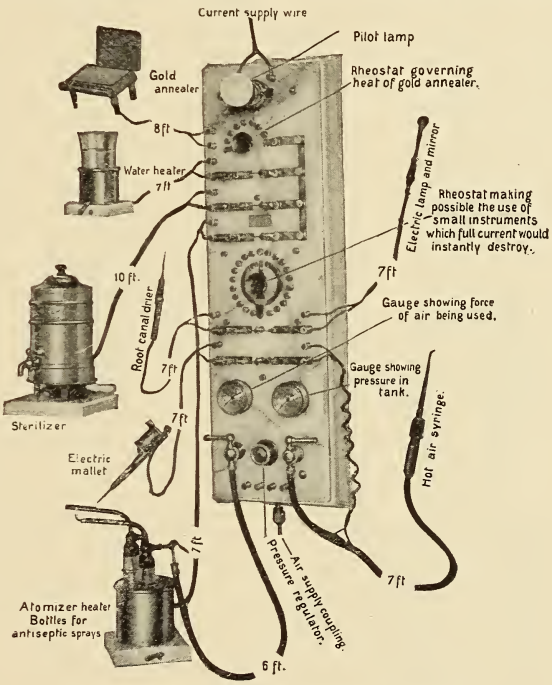
Mr. R.—Yes, and to think that the people of Venus had been sending signals to us for years before we had invented telescopes strong enough to observe them.

Mr. B.—Well, the world and all the other planets do move, don't they? One of these days some smart scientific chap will be inventing an airship that will enable us to fly from one planet to the other and then we'll have a chance to meet some of these interesting people up in the sky face to face. Well, here we are at Chicago. Glad to have seen you again. Good-bye.

Mr. R.—Good-bye.

Electricity in Modern Dentistry

Not so many years ago the small villages and towns about the country were visited on the average twice a year by "medicine shows" for the purpose of selling and advertising certain patent medicines. In fact, these wandering troupes are still to be found in many localities. Invariably among the members of the company was a professional tooth extractor who pulled teeth without pain. Toward him all the aching molars of the country side would naturally gravitate, and owing in part to the novelty and excitement of having the operation performed in front of a smiling and appreciative audience, instead of the more awe-inspiring dentist's office, and in part to the dexterity and strength of the operator, with perhaps a touch of cocaine here and there, most of the operations were in fact practically painless. "How does he do it?" The question was asked on all sides and invariably the wise ones who thought they knew would say that is was "by electricity." To have one's teeth extracted "by electricity" thus became quite the vogue.



THIS SHOWS THE FUNCTIONS OF THE DENTIST'S SWITCHBOARD

However amusing this conception of electrical dentistry may have been, it is nevertheless a fact that in the modern dentist's office electric current is made to perform a multitude of tasks, and the ingenious devices which the dentist has at his disposal are even more wonderful than the reputed electrical methods of the traveling tooth puller.

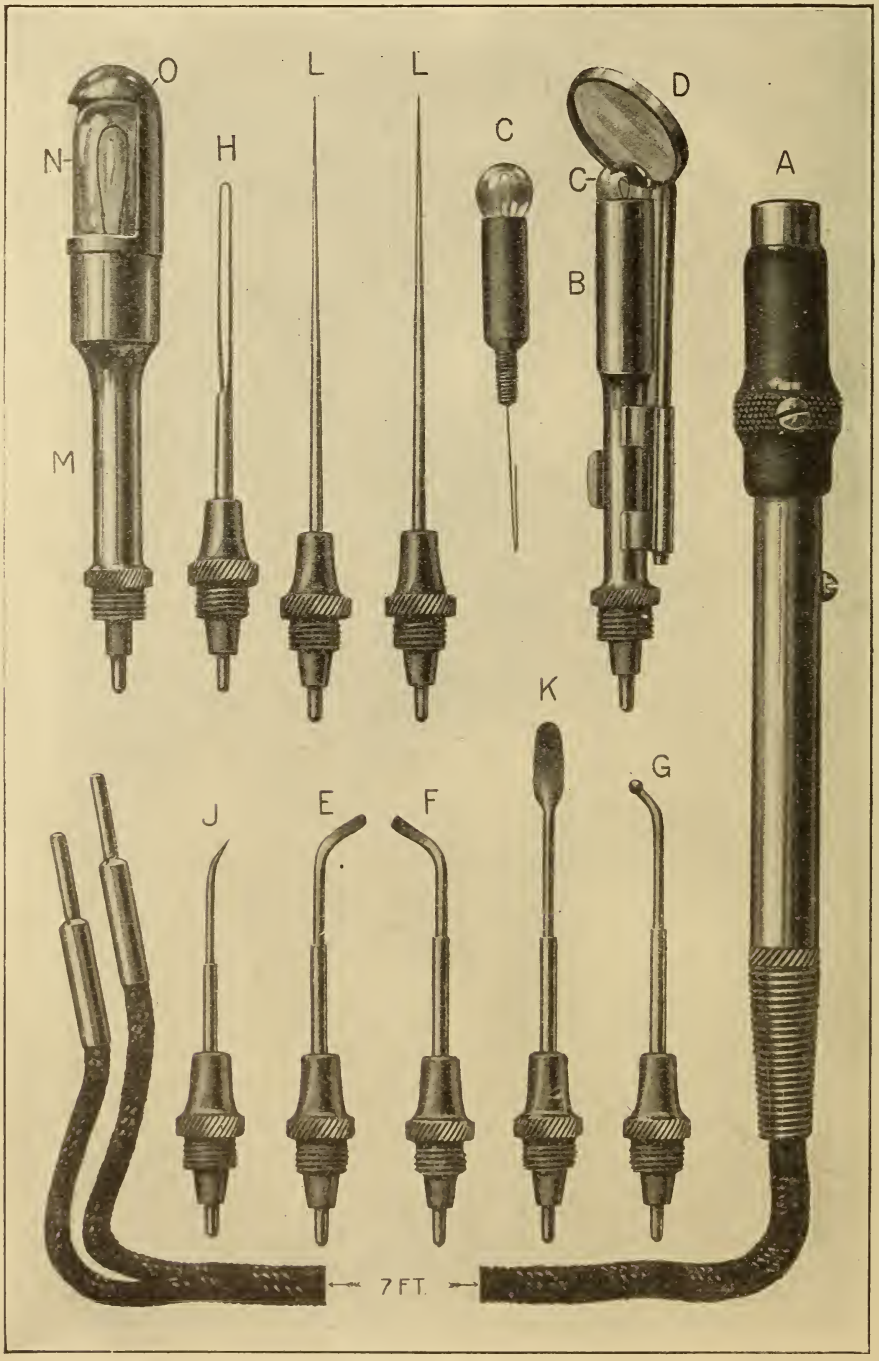
In the modern dental equipment the switchboard comes first and from it the dentist is able to control the flow of current to all the various devices which employ electricity. The particular board shown in the picture is of a pattern employing what is known as the shunt system of control used to increase or decrease the flow of current for the atomizer lamp, heating instuments, hot air syringe, etc., and is applicable to either direct or alternating current. The voltage for these instruments is first reduced by passing the current through one or more resistance lamps which are mounted on the top of the panel.

These boards sometimes have outlets for the 110-volt current, to which may be attached the engine, illuminator, fan, etc., each controlled by a separate snap switch. On the upper section of the board is a rheostat with a semi-circular row of button contacts. The function of this rheostat is to control the temperature of the gold annealer water heater, sterilizer, atomizer heater, bottles for antiseptic sprays, etc. These cups which are used for heating the atomizer bottles and water glasses are a distinctive feature. The circular row of buttons which you see at the center of the board is the rheostat which controls the low voltage current to the mouth lamp and heating instruments.

The dentist is likewise a user of compressed air for various purposes and the air pipe connections are also made to the switchboard which carries indicators showing the pressure at the tank and in the atomizers, syringes, etc.

Those instruments of the dentist in which

the victim has a sort of personal interest are shown in detail in the illustration below, the various instruments being lettered. (A) is the switch handle with a seven-foot conductor which leads to the low voltage outlets of the switchboard and is there con-



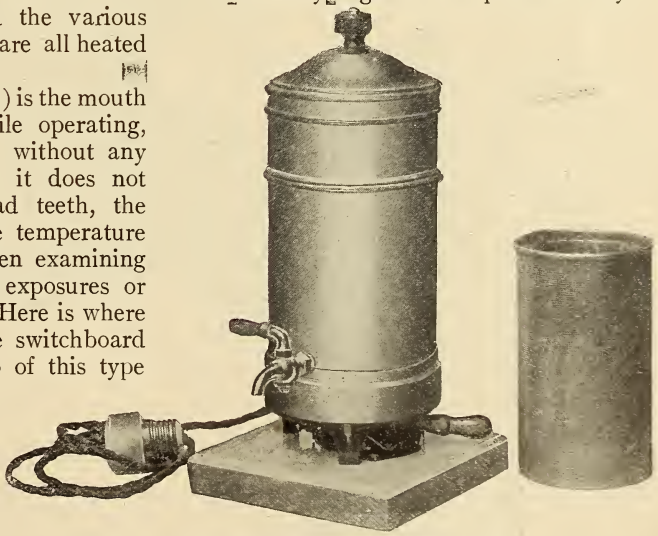
MOUTH LAMPS AND HEATING INSTRUMENTS USED BY DENTISTS

HOT AIR SYRINGE—THE AIR IS HEATED BY THE ELECTRIC WIRES AT THE LEFT

nected by the two small plugs. To this switch handle may be connected any of the instruments shown in the cut, and the various needles and wires and lamps are all heated by the electric current.

For instance, (C), (B) and (D) is the mouth lamp which can be used while operating, like an ordinary hand mirror, without any discomfort to the patient, as it does not get hot. For diagnosing dead teeth, the mouth lamp is surer than the temperature test, and it is very useful when examining approximal cavities, locating exposures or finding the orifices of canals. Here is where the low voltage feature of the switchboard comes in, for if a small lamp of this type were connected to the ordinary 110-volt circuit direct, it would be burned out immediately.

(H) and (L) show respectively a cautery and root canal driers. The former consists of a loop of platinum wire attached to the insulated sections of the tubular stem. It can be heated to an intense white heat and is highly recommended for sensitive dentine. It is frequently used for cutting off gum tissues overhanging into cavities, which can be done without hemorrhage. It is also used for puncturing abscesses, arresting hemorrhage after extraction and stimulating old sockets that are slow to heal. This instrument is made quite slender so as not to obstruct the vision and is just the proper length for manipulation. The cautery requires more current than any other instrument in the set, consuming eight amperes at six volts, or about the same number of watts taken by an ordinary 16 candle power lamp. The root canal driers are made of silver, which is an excellent conductor of heat and any degree of temperature may be instantly obtained by the electric current.



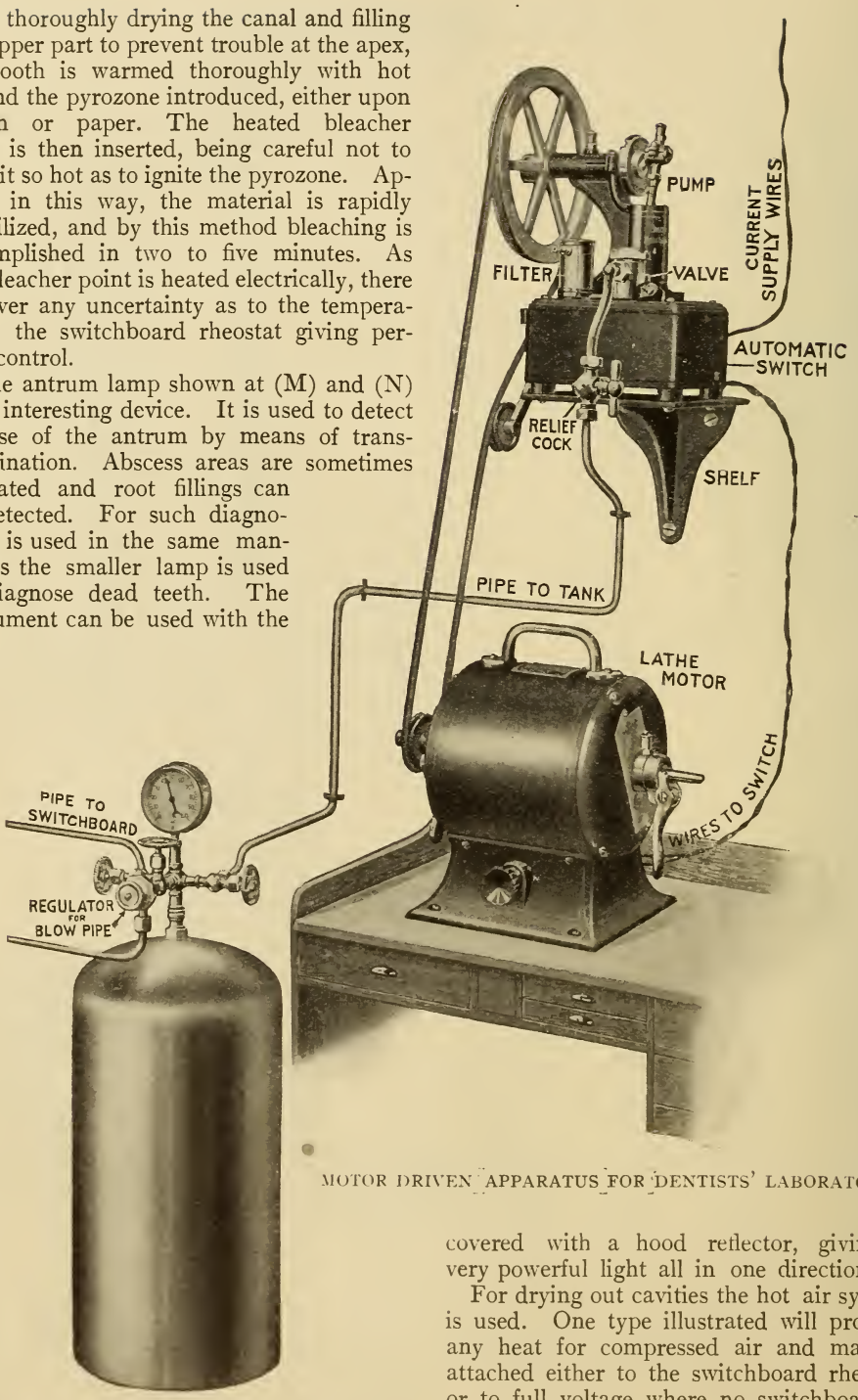
ELECTRIC INSTRUMENT STERILIZER

For softening gutta percha and working the material into a plastic state the instruments (E), (F) and (G) are used. (K) is a wax spatula for waxing up a plate.

The bleacher point shown at (J) was suggested by Dr. F. L. Stanton, and is used to hasten the action of pyrozone in bleaching.

After thoroughly drying the canal and filling the upper part to prevent trouble at the apex, the tooth is warmed thoroughly with hot air and the pyrozone introduced, either upon cotton or paper. The heated bleacher point is then inserted, being careful not to have it so hot as to ignite the pyrozone. Applied in this way, the material is rapidly volatilized, and by this method bleaching is accomplished in two to five minutes. As the bleacher point is heated electrically, there is never any uncertainty as to the temperature; the switchboard rheostat giving perfect control.

The antrum lamp shown at (M) and (N) is an interesting device. It is used to detect disease of the antrum by means of transillumination. Abscess areas are sometimes indicated and root fillings can be detected. For such diagnosis it is used in the same manner as the smaller lamp is used to diagnose dead teeth. The instrument can be used with the lips closed, and in a darkened room gives a very effective illumination of the tissues. The bulb, which is 15 candle power, is covered with a hood reflector, giving a very powerful light all in one direction.



MOTOR DRIVEN APPARATUS FOR DENTISTS' LABORATORIES

For drying out cavities the hot air syringe is used. One type illustrated will produce any heat for compressed air and may be attached either to the switchboard rheostat or to full voltage where no switchboard is used. The instrument is mounted at right angles to the end of the tube and is easy to hold and operate. When the lever is pressed

air from the tube is allowed to escape through the nozzle. The air in the tube is heated electrically by resistance wires in the collar which encompasses the tube at the left.

The electric sterilizer shown in one of the cuts consists of a cylindrical vessel and a disk heater mounted on a marble base. It will boil a pint of water in 20 minutes. The perforated basket with two compartments holds both small and large instruments in the heated sterilizing bath in the vessel. In the dental laboratory, which the patient seldom sees, are many interesting devices for making teeth, inlays, etc. The dentist generally has a lathe, and polishing and grinding machines. In the up-to-date laboratory a motor is used for this purpose. This motor may also be made to drive the air compressor outfit as shown in one of the cuts.

Why High Efficiency Lamps should be Frosted

By ROSCOE SCOTT

Non-technical persons who have been accustomed to the use of carbon filament lamps sometimes regard the illuminating expert with suspicion if he advises them to use frosted bulbs when installing tungsten or tantalum lamps. They regard such advice with incredulity much like that of the small boy who is told that green apples are not good for him. Lamp consumers of this matter-of-fact persuasion reason thus: "Frosting hides the light source; *ergo*, it cuts down the light; *ergo*, if I buy frosted lamps, I am actually paying for a decrease in illumination."

Let us look into the case a little more fully, and we shall see that the practice of frosting arose from no desire to gull the consumer, but from easily proved physiological and scientific facts.

Look at the lighted filament of a clear tungsten lamp steadily for a few moments. Now close your eyes, and you will continue to "see filaments" for a long time. If your eyes are not strong, they will "weep," and you may even find that you have given yourself a headache. Continued repetitions of the experiment would be ruinous. These physiological effects are due to what is vaguely called "glare," and in the technical language of illumination, "intrinsic brilliancy." Intrinsic brilliancy may be expressed numerically as so many "lumens" per square inch of luminous surface. A lumen is the commonly accepted unit of light-flux, and may be defined very simply as follows: If a light-source having a strength of just one candlepower in every direction be placed at the middle of a transparent sphere one foot in radius, then every square foot of surface of that sphere will have exactly one lumen of light passing through it.

Some actual measurements which were made on two high-efficiency lamps will make the effect of frosting clear.

TABLE NO. 1 (LAMPS CLEAR)

	Lamp No. 1	Lamp No. 2
Lighted diameter of filament (inches)	.00207	.00172
Length of lighted filament (inches)	23.4	20.6
Area of surface of lighted filament (sq. in.)	.152	.111
Total number of lumens of light given out	424	282
Lumens per square inch	2790	2530

The process of frosting these lamps reduces the intrinsic brilliancy (glare) from the above values of over 2500 (intolerably high for general use) to comfortable values of about ten, as will be seen in Table No. 2.

TABLE NO. 2 (LAMPS ENTIRELY FROSTED)

	Lamp No. 1	Lamp No. 2
Area of surface of the luminous bulb (sq. in.)	36.6	29.6
Number of lumens passing through frosting (only 10 per cent absorbed)	382	254
Lumens per square inch	10.4	8.6

Where bowl-shaped diffusing reflectors of holoplane glass are used, it is not necessary to frost more than the lower half of the bulb, as the reflector itself diffuses the light from the upper portion.

The beneficial effects of frosting may be further illustrated by the following rather whimsical parable.

Gold, like artificial light, is one of the luxuries which civilized man has come to regard as a necessity. Suppose that gold descended in intermittent showers from the

Seeing Things at Night

If O. U. Bill Elk, just back from the big reunion of the herd at Los Angeles, tells you that he saw pretty girls riding around the streets on giraffes, and tries to describe the horrible sea serpent, green and scaly and shooting fire out of its eyes, it is not necessary for you to urge him to sign the pledge. You see, such things actually exist in California, though they are not to be found all the year round, but only on occasions like the recent national conclave. Then, with the efficient help of the electric railway and lighting companies, wonderful electrical spectacular effects are obtained.

The photographs are of two floats out of a score or so which literally made night hideous. They were mounted on trucks and propelled by a trolley through the main streets, forming the finest electric parade ever witnessed in the Southern California metropolis.

Besides the sea serpent and the rubber-neck giraffes, there were many old friends in new guise: the wild man of Borneo, the Teddy bear, the trick elephant, Mary's little lamb and Maud (a Kicker), besides a number of others too awful to talk about, and which could only be conceived by the versatile mind of an Elk.

skies and that in order for a man to possess any of the precious metal it was absolutely necessary for him to catch it with bare hands as it fell. It is safe to assume that the maiming effect of gold nuggets falling with express-train speed would detract largely from the pleasure of feeling them in one's hands. Now suppose that instead of descending in nugget form, the metal were beaten into gold-leaf, strips of which were dropped from the clouds and wafted their way down to the expectant hands of mortals below. Men would welcome such a change even if the amount of gold falling were decreased.

The decrease in velocity of falling gold corresponds, in the everyday world, to the decreased glare of light sources which have been frosted. There is, however, this difference, that the harmful effects of brilliancy in overdoses are not always felt at first. Sometimes an evening of close work by the light of unconcealed tungsten filaments will cause eye-strain, when the same annoying glare could be endured for a shorter length of time with impunity.

As a general rule one can well afford to cut down his total lumens of light, 10 per cent by frosting, when the same process reduces his lumens per square inch by several thousand per cent.

POPULAR ELECTRICITY WIRELESS CLUB

Membership in Popular Electricity Wireless Club is made up of readers of this magazine who have constructed or are operating wireless apparatus or systems. Membership blanks will be sent upon request. This department of the magazine is devoted to the interests of the Club, and members are invited to assist in making it as valuable and interesting as possible, by sending in descriptions and photographs of their equipments

Some Notes on Spark Gaps

By ALFRED P. MORGAN

The oscillator or spark gap is one of the most important yet often the most poorly adjusted parts of a wireless station. The possible distance of transmission with a given set of instruments is greater with an increase of energy, and the energy stored in the oscillation circuit varies with the capacity of the circuit and the square of the difference of potential to which the opposite

FIG. 1. SPARK GAP FOR SMALL UN-TUNED TRANSMITTER

sides of the oscillator are raised. Therefore by lengthening the spark gap, since a greater potential then exists and more energy is stored, the radius of the station may be increased. Also if the gap is too short the discharge will form an arc and the only oscillations taking place will be those corresponding to the frequency of the charging current.

But there is a strong tendency for an amateur operator to open out his spark too wide. He is tempted to open it ou as long as sparks jump steadily, for the extra noise thus occasioned seems to please him. The greatly increased resistance thereby offered to the released charge may be so great that the disruptive discharge will not oscillate but merely set up a unidirectional current. To obtain a good oscillatory discharge with little damping it is necessary to make the resistance of the transmitting circuit as small as possible. The greatest part of the resistance is in the spark gap, and therefore this should be kept short. The proper length for a spark gap is a compromise between the two extremes.

Arcing is often caused by insufficient condenser capacity in the oscillation circuit. But if the capacity is increased the spark gap must also be made slightly longer, provided of course that an increase in the amount of energy supplying the coil or transformer is available, as otherwise the potential of the condenser may not be sufficiently raised to permit a discharge to pass across the arc.

The proper length for the gap may be approximated by an experienced operator by the appearance of the discharge. If too short, the spark will be hissing and

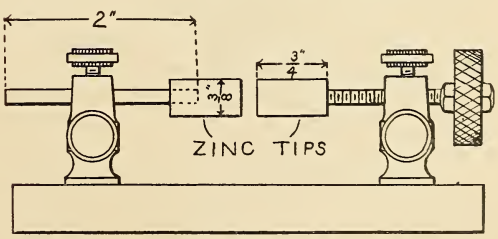


FIG. 2. SIMPLE ZINC SPARK GAP

flaming and is in extreme cases red or yellow colored. It should be lengthened out until it is thick and white and a slight increase in the sound is noted. The spark should not be, as commonly thought, stringy and crackling.

The only way the adjustment may be really ascertained is by means of a hot wire ammeter placed in the aerial circuit.

The proper gap length is then indicated by a maximum reading on the meter.

Spark gaps exist in various sizes and forms. The different types all possess inherent advantages and each is best suited to the style of apparatus for which it was designed.

The best spark gap for use with a small untuned transmitter making use of neither tuning helix or condenser is shown in Fig. 1. It consists of two brass balls about one inch in diameter supported by suitable binding posts. The balls tend to thicken the spark and make it more disruptive than if it passed between rods or points. The balls also increase the potential required to leap the gap and permit the aerial to become more highly charged before a spark takes place. For this reason the spark balls or knobs must always be kept free from rough spots and points by frequent polishing.

Zinc has some peculiar property whereby it is the most efficient material for a spark gap. Brass is second. The use of zinc is somewhat limited to any but small stations as the excessive heat generated by large transformers or induction coils rapidly corrodes and melts the zinc electrodes. Amateur stations using small induction coils will secure good results with the simple and efficient type of zinc spark gap shown in Fig. 2. It is easily made by fitting two pieces of zinc battery rod $\frac{3}{4}$ inch long and $\frac{3}{8}$ inch in diameter to the ends of two brass rods $\frac{1}{8}$ inch in diameter and $2\frac{1}{2}$ inches long. The rods are supported by two ordinary double binding posts, one of them provided with screw threads for adjusting.

A spark gap of the type just described would be unsuitable for a large transformer or induction coil. One having heavier parts of less resistance and better able to stand the heat is shown in Fig. 3. If desirable the dimensions of a gap of this type may be reduced and made suitable for a small coil in place of the gap shown by Fig. 2.

A piece of hard rubber rod (R) one inch in diameter and $2\frac{1}{2}$ inches high serves as a standard. Four grooves $\frac{1}{8}$ inch apart better the general appearance and also reduce leakage in event of any moisture collecting on the rubber. The upper electrode is supported by (S) a strip of brass one inch wide, $3\frac{1}{2}$ inches long and $\frac{1}{4}$ inch thick. A hole is bored and tapped to receive (P) which is a piece of brass rod $\frac{1}{4}$ inch in diameter and $2\frac{1}{2}$ inches long. A second hole permits a binding post to be screwed into the top of (R). A small brass pin (Z)

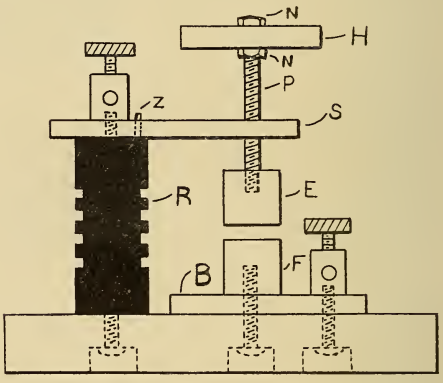
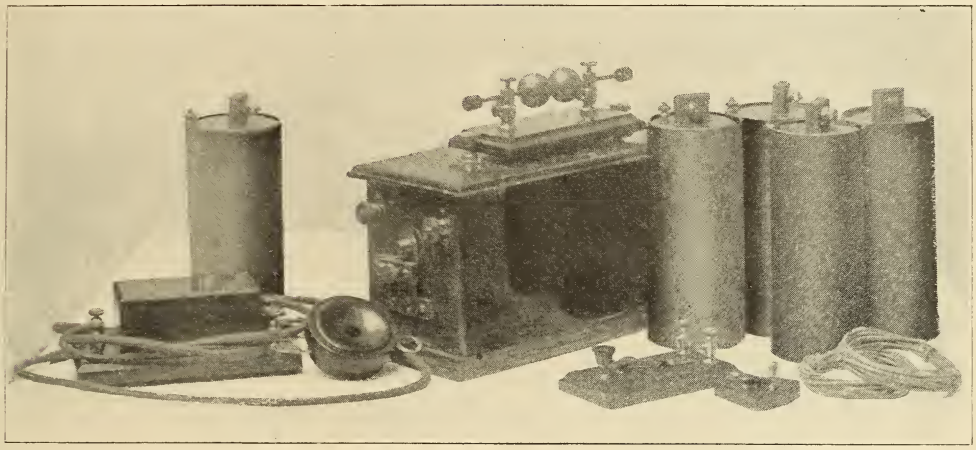


FIG. 3. ZINC SPARK GAP FOR HEAVY WORK

one-sixteenth inch in diameter and $\frac{1}{2}$ inch long projects into (S) from (R) in order to prevent (S) from slipping. A fibre head (H) two inches in diameter and $\frac{1}{4}$ inch thick is clamped on the upper end of (P) by means of the two nuts (NN). The electrodes (E) and (F) are cylinders of brass $\frac{3}{4}$ inch in diameter and $\frac{3}{4}$ inch high. The upper electrode (E) is bored and tapped to fit the lower end of the rod (P). The lower electrode (F) is fastened to the base by means of a screw passing through (B). (B) is a strip of brass $2\frac{3}{4}$ by 1 by $1\frac{1}{4}$ inch. A second hole allows a binding post to be fitted on (B). The base is made preferably of hard rubber or fibre.

Five-Mile Wireless Outfit

Many amateur wireless experimenters will no doubt derive a great deal of pleasure and benefit by building their own apparatus, but there are also many who would prefer to obtain a good working equipment at the start, from some reliable manufacturer. A small equipment of this sort is here illustrated. It is intended for actual work up to five miles under all conditions; not simply when the atmosphere is just right or when the detector happens to be "feeling fine."



FIVE MILE WIRELESS OUTFIT

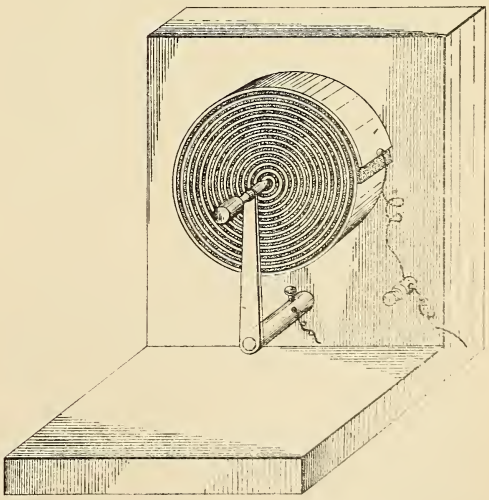
The detector is of special design and is one of the important features of the set. It needs no more attention than a telephone receiver, and is less liable to get out of order. Unlike the electrolytic, it cannot be burned out by the transmitting station, and requires no potentiometer. Unlike the needle-carbon detector, it does not arc, and is not affected by jarring and at the same time it is sensitive.

The head receiver is a neat little instrument built to be sensitive and light, the weight having been reduced to a minimum. The permanent magnet is constructed with a view to giving the greatest efficiency.

Another important feature of the outfit is the induction coil, which was designed exclusively for wireless. The secondary is wound with comparatively heavy wire in order to produce the thick, hazy spark so desirable for wireless transmission. Dry cells are shown in the cut which work satisfactorily for experimenting, but for commercial use, primary or storage cells are preferable.

Wireless Tuning Coil

Lee De Forest has recently taken out a patent on a new type of tuning coil which is shown in the illustration. The coil consists of a thin strip of copper or brass ribbon wound in the form of a spiral, the convolutions being separated by a thin ribbon of silk insulation or cellulose acetate. It is then mounted on a frame with the edge of the ribbon outward, and a contact maker in the shape of a crank is arranged so that the contact point as it is moved outward cuts out the successive convolutions.



DEFOREST'S NEW TUNING COIL

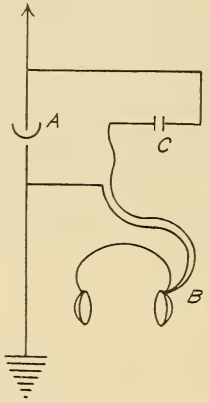
WIRELESS QUERIES

Answered by Valentine B. Seitz

Head Band Receiver and Condenser

Questions.—(A) Please give a diagram of the connections of a wireless receiving station with a head band and receivers. (B) How large should the plate condensers be for a set of receivers of 75 ohms each? (C) Are plate condensers as good as leyden jars?—H. T., Marysville, Ohio.

Answers.—(A) The diagram of a receiving set using head telephones is given below. (A) is the detector, (B) the receiver and (C) the battery. In this case you must use the liquid or some other type of self-restoring detector.



RECEIVING SET USING HEAD TELEPHONES

(B) The condensers used in the receiving circuit are made of very thin metal plates and the plates so arranged that the capacity can be easily and quickly varied by moving the plates over or from one another. In the receiving circuit shown in answer (A) no condenser is needed.

(C) Yes.

A 100 Mile Transmission

Questions.—One hundred miles from this city there is a station of ten kilowatts and between us are mountains higher than the place where the city is located. (A) Could messages be heard over this distance? (B) What height must the antenna have? (C) What kind of apparatus is necessary? (D) Would a soldered connection with the tubing be sufficient? (E) What resistance must the apparatus have, the tuning coil and the telephone?—F. T., San Jose de Costa Rica.

Answers.—(A) Yes.

(B) About 70 or 80 feet.

(C) A tuning coil, condenser, pair of 1500 ohm receivers and any good thermo-electric detector.

(D) Your question is not clear.

(E) The sensibility of a receiving set is never given by its resistance. Telephone receivers are spoken of by their resistance; 1500 ohms being a good average for wireless work.

Spark Coil and Condenser

Questions.—I have wound a jump spark coil consisting of 42 turns of 14 gauge copper wire for the primary and 2450 turns of 28 gauge d. c. c. copper wire for the secondary. I want to operate this with 10 volts. (A) What will be the limit of the spark gap? (B) Can I make a condenser of 14 gauge rubber covered copper wire, if so, how much will it take?—L. R., Cottonwood, Idaho.

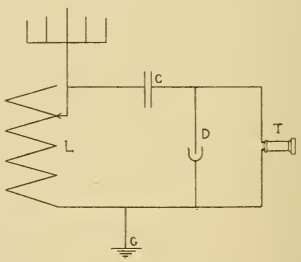
Answers.—(A) As you have not given size of core, etc., we cannot tell the length of spark. You will probably find that both your primary and secondary have too few turns. With a high speed vibrator and a well-proportioned core you will probably get about $\frac{1}{8}$ inch.

(B) No.

Connections for Wireless Outfit

Questions.—(A) Please show diagram for connecting outfit consisting of a tuning coil, silicon detector, one 75 ohm receiver, condenser and aerial 50 feet from ground. (B) Do I need other instruments to make my receiving set complete? (C) With what wire should I re-wind my receiver to make it 2000 ohms and how much?—H. J., Gloucester, Mass.

Answers.—(A) See diagram.



CONNECTIONS OF WIRELESS OUTFIT

(B) The set described is complete in itself, but if you wish to make any improvement would advise using a receiving transformer in place of the tuning coil.

(C) Rewind your receiver with No. 40 enameled wire, getting on as many turns as the magnet spools will hold. Receivers having from 1500 to 2000 ohms resistance per pair, give the best results.

Sending Helix; Wave Length; Ground Connections

Questions.—(A) What size of wire shall I use on my sending helix and what is the diameter and number of turns and distance between each turn? (B) How do you put on the slider? (C) How do you find wave length with this tuning coil and 100 foot aerial suspended 75 feet high? (D) Should the ground be near the instruments? What size of wire is best?—R. R. L., Washington, D. C.

Answers.—(A and B), See answer to L. R. in the September, 1909, issue.

(C) The data given is not enough to find what the wave length will be. You can find out near enough, by having some one compare your tuning point with that of some other station having a known wave length.

(D) It is not necessary to have the ground near the instruments, but the straightest or shortest distance is the best. You will find No. 10 wire heavy enough for a one K. W. set, but the Board of Fire Underwriters call for No. 4 in some sections.

United Wireless Apparatus

Questions.—(A) Please show diagram lilustrating the connections of the United Wireless Company's equipment. (B) Is the potentiometer the same as the DeForest tuning coil and may it be used instead? (C) Could 110 volt current be used for this equipment?—M. T. B., St. Francisco, Wis.

Answers.—Your question is rather general, as you do not mention any special type of set. The different sets put out by the United Wireless Company vary in construction and method of connection.

(B) The potentiometer and tuning coil are quite different in construction and use. The potentiometer is used to vary the voltage in the detector circuit, while the tuning coil is used to bring the receiving set in resonance with the sending station.

(C) One hundred and ten volts alternating current with a transformer would give most satisfactory results.

Apparatus to Receive 100 Miles

Question.—What instruments are required to receive wireless messages up to 100 miles and how are they connected?—O. E. H., Baltimore, Md.

Answer.—(A) The above question is quite frequently asked by different people, and is one that cannot be answered, unless all conditions are taken into consideration. A ¼ K. W. transmitting set, working under good conditions, over water at night, should be heard over a distance of 100 miles with a good receiving set. The receiving set should consist of a tuning coil, condenser, receivers and electrolytic or any good thermo-electric detector. The same sending set working in the day time and not under such favorable conditions, probably would not operate over 10 miles. It can therefore be seen that the answer to the above question as to the receiving ability is one that can be better judged by the amateur himself. See diagram to C. H. C.

Potentiometer; Rotary Condenser; Electrolytic Detector

Questions.—(A) Is it best to have one or one-half ohm steps on a potentiometer? (B) Explain the rotary type variable condenser. (C) Is there a commercial wireless station in Kansas City, Mo., or Kansas City, Kas.? (D) How strong a battery current should be used with an electrolytic detector?—I. H. W., Eskridge, Kas.

Answers.—(A) This would depend upon the total resistance and number of turns in the potentiometer. If the coil has a resistance of 500 ohms and is to be used with an electrolytic detector, steps of about two or three ohms will be sufficient.

(B) The use of the rotary condenser is the same as that of the slide type, the only difference being in the construction. A bank of semi-circular plates, pivoted between two bearings, are placed so that they can revolve between a set of similar stationary plates.

(C) None, to our knowledge.

(D) Electrolytic detectors work on about 1.6 volts.

Microphone Transmitter; Break in Antenna

Questions.—(A) How is a microphone transmitter for very high voltage made? (B) If the cable leading to the antenna breaks so there is no more electrical connection with the spark gap what would happen if the coil were kept working? Would any damage be done to the apparatus?—O. S., Clinton, Mass.

Answers.—(A) Microphone transmitters for high voltages are more or less troublesome and are not generally used. We would advise the use of one of the common types in connection with a transformer in a shunt circuit.

(B) The spark at the gap will continue, but no harm will be done. If the spark gap is opened beyond sparking distance, the voltage on the free end of the coil might be raised enough to puncture the insulation.

ELECTRICITY IN THE HOUSEHOLD

The Evolution of Electric Heating

It seems almost incredible that within the span of less than a half dozen generations there could have been made such a remarkable advance in the methods of the comparatively simple process of boiling water. The cover design of a little booklet issued by a manufacturer of electric water heaters emphasizes in a striking manner the course of this development, and shows us in a manner more forceful than words that this is truly the electrical age in which we are living. The savage Indian heated water as best he could by raking hot stones out of the campfire and throwing them into the liquid. To our grandfathers the open fireplace with its ponderous kettle was a substitute for the crude methods of the natives. Later the familiar cookstove with its complement of pots and kettles was a much appreciated improvement. And now, at the turn of a switch it is possible to procure boiling water at any time and anywhere that the current giving wires are available.

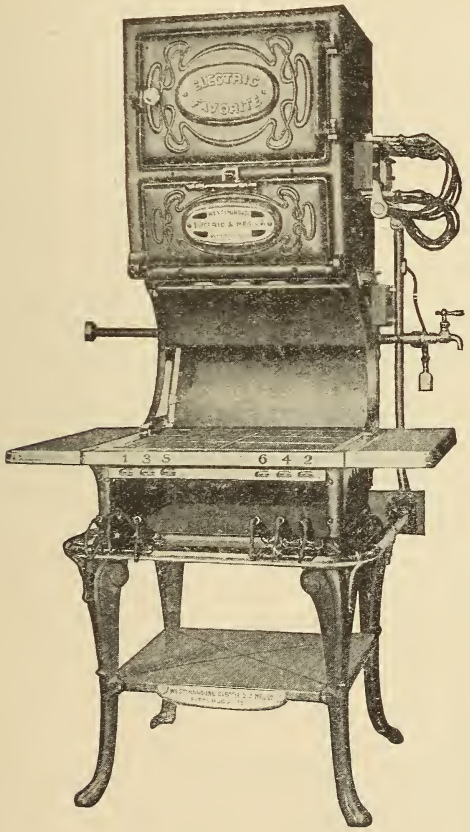
The uses of an instantaneous water heater are many. In the home it will serve in the sick room, as well as at the buffet. To the physician it is valuable for sterilizing water. In dentistry the needs of hot water are more frequent, and the device is especially adapted for this work, even satisfying the demands of the laboratory. In cafes, etc., there is a constant demand for an instantaneous heater. Hot water may be obtained while the glasses are being procured. At soda fountains and in candy stores such a heater may be adapted to a score of purposes.

There are, in fact, hundreds of classes of people to whom the electric heater is invaluable, but how many stop to think how comparatively short has been the time in which this and similar labor saving electrical conveniences have been taking form.

The Latest in Kitchen Ranges

Cooking by electricity means no fire to kindle and keep up, no ashes, no smoke, no dirt, no gas fumes, no menacing probability of explosion. These things are what make it the only form of heat that is absolutely sanitary and free from all objectional features. That it is ideal for cooking purposes is apparent from its very nature.

The principle of the electric heater has been known and made use of in a limited



LATEST KITCHEN RANGE

way for many years. There has remained, however, a problem for the engineer to work out; namely, the construction of a heating element combining efficiency, simplicity and durability in a manner that the stove may be recommended for daily domestic use. The latest solution of this problem is a heating element which is embodied in one of the latest types of electric range, which is shown in the picture. This element is made of a practically indestructible material that converts the electric current into heat at the exact point where it is wanted and in the most effective manner. The range which contains it corresponds in appearance with the most modern design of gas range, and the cooking surface consists of six distinct heating units, each of which can be used independently of the others.

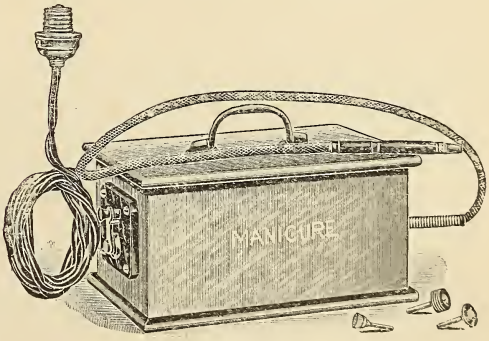
Both the oven and the broiler are located above the stove so that no stooping is required. The oven is heated by five distinct heating units, so connected that any one or combination may be used without switching in the others.

The broiler is heated by five units similar to the oven. This heating by separate units makes it possible to regulate the heat with great exactness, and keep it at the temperature desired.

Beneath the broiler is located the reservoir, getting its heat from a double immersion coil. Under the cooking surface is an open plate warmer and beneath this is a shelf for cooking utensils. All of the heating units are readily accessible for cleaning. There are no stove lids to bother with for the heat is in the stove top itself and not underneath, as in all other stoves except the electric.

Electric Manicuring Outfit

This outfit consists of a motor and flexible shaft for holding the manicuring instruments, all mounted in a compact mahogany case. Current is supplied through a cord

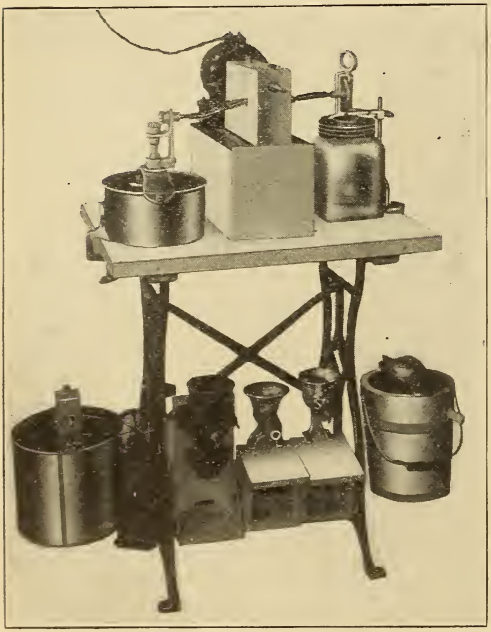


ELECTRIC MANICURING OUTFIT

and plug from the lighting circuit. There are various little grinding, polishing and buffing wheels which go with the equipment.

The Automatic Kitchen

We know all about necessity being the mother of invention, etc., and it was for this reason that Adolph Aderer was impelled to invent the "automatic kitchen." Mrs. Aderer was not very robust, and as they lived in New York she was severely tried by the servant problem which has become so complex in the larger cities. In order to



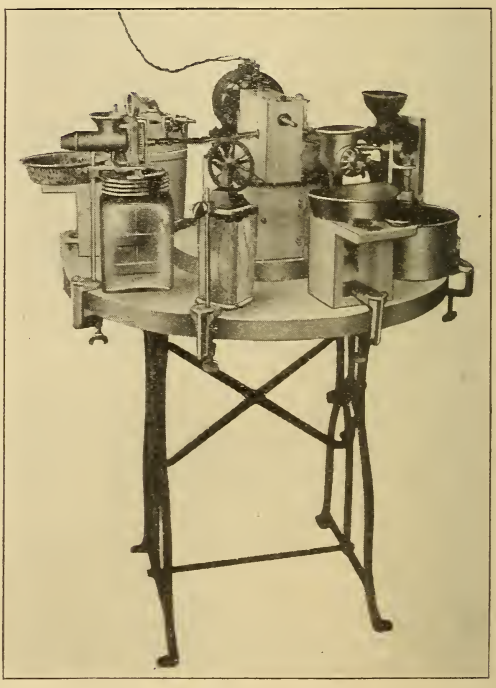
AUTOMATIC KITCHEN NO. 2

lighten her task Mr. Aderer worked out the idea of the automatic kitchen. The first machine was used in their home and in the early stages of its development it worked so imperfectly that both machine and inventor were at times near being thrown out of the window.

But it was no Mr. Bowser idea, as results finally proved, for after much thought and experimenting, and aided by helpful suggestions from the future user of the machine, he was able finally to bring it to such a practicable stage that it made the kitchen absolutely independent of servants. Then of course the next step was to make machines for the market and give other housewives the advantage of its labor-saving possibilities.

The mechanism of the machine is very simple. Extending from the motor is the main shaft, a part of which carries two worms connected to two worm gears, each of different size, giving two speeds. The worm gear spindles or shafts are set inside of an eccentric bushing, the turning of which by means of small handles permits the bringing of the gears into or out of mesh with the worms, this allowing each of the gears to be run independent of or together with the other. Attached to each of the gears is a flexible shaft, the ends of which have half round sockets.

All utensils to be used are provided with half round spindles fitting into the sockets



AUTOMATIC KITCHEN NO. 3

on the shafts. These spindles are inserted into the sockets, the utensils are clamped to the table, and are then ready for operation.

The above description appertains to automatic kitchens Nos. 1 or 2, No. 2 being shown in one of the illustrations. The former has only one flexible arm for the use

of only one utensil at a time, while the No. 2 has two flexible arms, permitting the use of either one or two utensils at a time.

The No. 3 machine is the same as number 2, except that it is mounted on a round table top, part of which revolves around the base; base and motor being stationary.

All the utensils are clamped to the table in their respective positions and are only removed for cleaning purposes. Each of the flexible shafts of this machine is provided at its end with a slip-joint socket, permitting the attaching and detaching of the arm by the simple pressing backward of the socket, without the necessity of unclamping the utensils from the table.

These machines may be operated by a child, after a half an hour of instruction, and that without any trouble or danger.

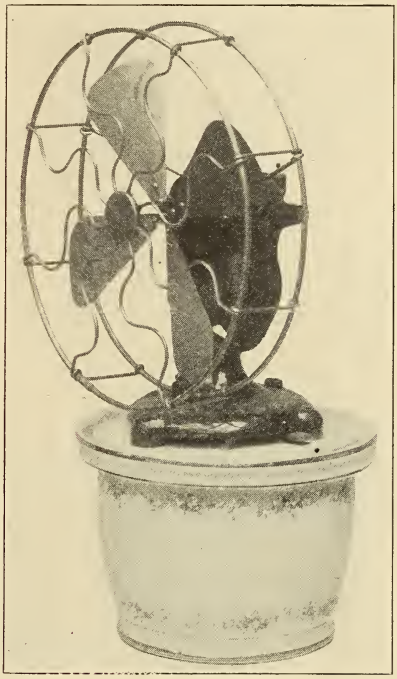
Cooking With Incandescent Lamps

The "fireless cooker" is the latest departure in electric cooking devices and the unique feature about it is that all the heat necessary to do the cooking is derived from four incandescent lamps. As everyone knows, a comparatively small amount of heat is required to perform the simpler cooking operations, such as boiling water, cooking cereals, etc. The trouble lies in confining the heat and applying all of its energy to the cooking process. This is what the fireless cooker does.

As will be seen in the illustration, the cooker consists of a cylindrical pail the sides of which are double and interlined with asbestos, which almost entirely prevents loss of heat by radiation. In the bottom of this pail are arranged four incandescent lamps provided with a cord and plug for attachment to an ordinary lamp socket. Above the lamps and suspended from the rim of the pail is a conical vessel containing the materials to be cooked. Over this is a heat retaining cover. The lamps are arranged so that all or a part of them may be used at once, providing for a quick, strong heat or a slow, simmering heat.

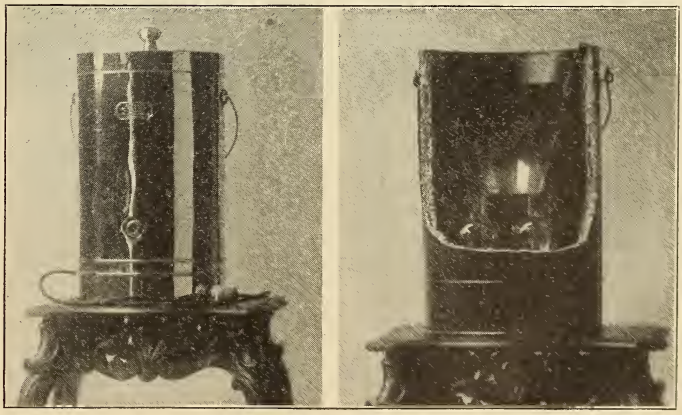
Portable Fans

Any office, home or place of business not having electric wires may still have an electric fan, for a portable one driven by a storage battery is at last obtainable. The battery is carried in an ornamental jar and

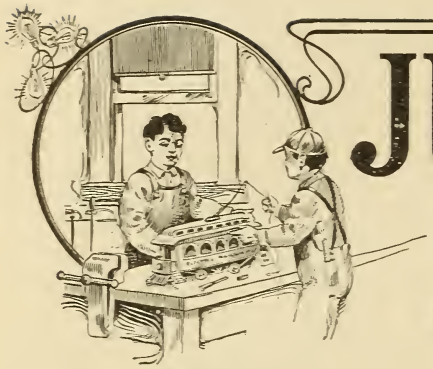


PORTABLE FAN

it furnishes sufficient current to operate the nine inch fan for 50 hours' continuous operation, after which it may be recharged for 50 cents.



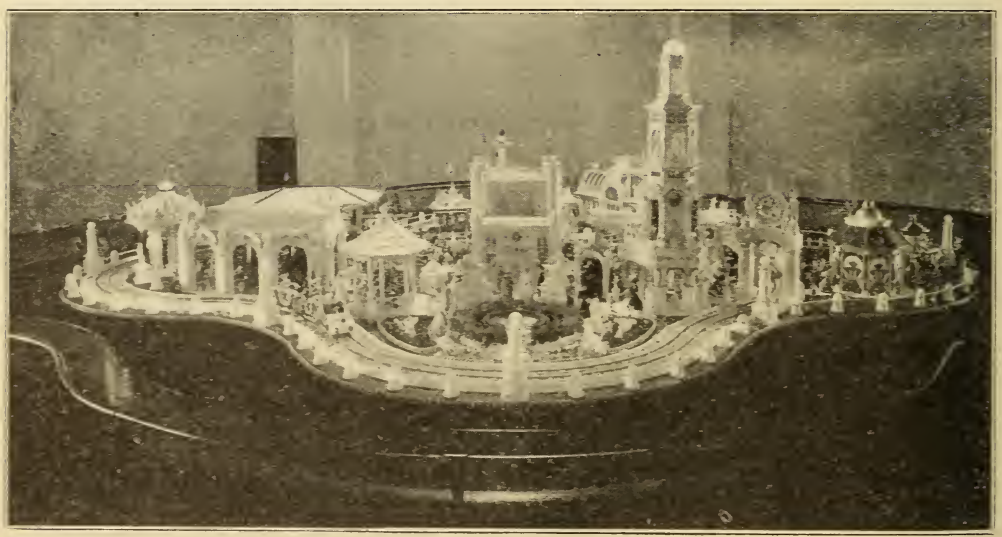
ELECTRIC "FIRELESS" COOKER



JUNIOR SECTION

A Magic City

"Magic City," which is to be found at San Souci Park in Chicago is one of the most marvelous in detail and picturesque in appearance, of any of the notable miniatures that have been shown from time to time in America. It represents the ingenuity of two young Chicagoans—George McCall Black and Arthur Frazier—and their undivided attention during the working hours for nearly four years. This little miniature, occupying a platform about 20 feet in circumference, possesses everything in the way of life and architecture, that would combine to create the city beautiful. It includes fourteen separate and distinct buildings, set among gardens, statuary, fountains and lagoons. It is illuminated by 14,000 four-volt incandescent electric lamps, some in colors, and the majority of them flashing alternately. It is operated from its own plant by electricity and compressed air. Among the buildings are a power house in operation, a band pavilion with a miniature band playing by phonograph attachment. a German beer garden filled with merry-makers, a lighthouse in the lagoon, an administration building with an illuminated tower, an electric pavilion. an Italian fruit stand, grand central railway station, and a menagerie in which all of the lions, tigers, bears and alligators seem to be alive. There are singing, moving birds on the lawns, a little railway train "toots" as it runs around the city, and the boats and swans on the lagoons are moving all the time.



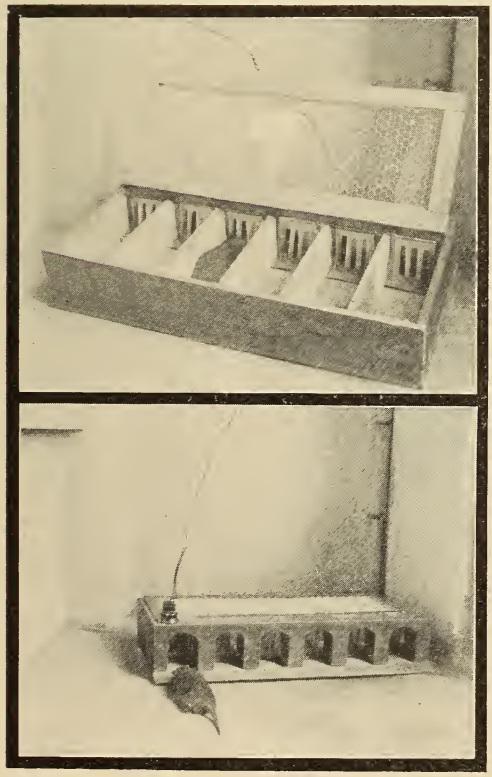
"MAGIC CITY"—A WONDERFUL MINIATURE

The detail is so perfect that a midget man is seen mowing the lawns, a fortuue teller is displaying her cards in the Hindu booth and a bridal party actually walks out of the Cathedral. The buildings are all in white enamel, decorated with gold.

The "Magic City" was originally intended for the Alaska-Yukon exposition, but would not be completed in time for the opening of that affair. It required the services of four men an entire month to install it, so intricate and innumerable are the details.

Killing Rats by Electricity

The problem of rat extermination becomes a serious one, especially in seaport cities, where the danger of infectious diseases, brought in by the rodents, becomes alarming. Traps, poison, smoke, etc., are em-



ELECTRIC RAT TRAP

ployed for the extermination of the pests, but they all have their drawbacks.

A method of killing rats by electricity has been invented by a citizen of Vienna, Austria, which is certainly cleanly and humane. The device consists of a box with a number of entrances through which the rat must pass to get to the bait within. Little metallic gates, hinged at the top, are provided, which the rat pushes open as he enters. These gates are made one terminal of an electric circuit. The other terminal is connected to wires in the bottom of the box.

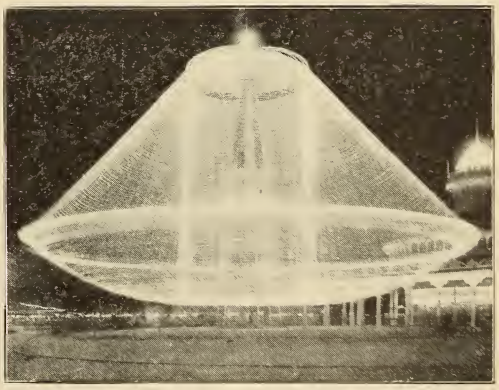
The rat, having thrown open the gate, closes the circuit by touching the wires. He is then almost instantly killed by the current flowing through his body, and no blood is to be seen.

The inventor made experiments in the presence of officials from the German Navy, the police, slaughtering house, municipal markethalls, in the Berlin electric power stations, etc. It was even found that three rats, having been imprisoned in the same compartment, were killed at one time.

The apparatus has been so much improved, recently, that 110 volt continuous current, or even only 40 volt alternating current, is sufficient to kill a rat. This permits the trap to be installed everywhere, in the private homes, cellars, stables, kitchens, etc., where such current is to be found.

Unusual Photograph of Moving Lights

At first sight one would be led to believe that some extraordinary new scheme had been devised for utilizing electric lights to amuse the public. This freak picture is however nothing more or less than a reproduction of a time exposure photograph



PHOTOGRAPH OF MOVING LIGHTS

made of one of the giant airship amusement devices, frequently seen in summer parks.

Miniature airships are suspended by long cables from a lofty tower. The platform from which they are suspended is then made to revolve. As the ships travel in a circle, faster and faster, the centrifugal force tends to throw them outward, and, as the cables cannot elongate, they are of course lifted at the same time. The cables, the tower and the ships are all outlined with electric incandescent lamps, and all these individual points of light, as they move across the photograph plate, leave a path which shows white on the photograph print.

How to Build a Simple "Shocking" Coil

Many questions have been asked by readers of the Junior Section, and others, relative to the construction of a simple induction coil or "shocking coil," as it is often called. More pleasure can be derived

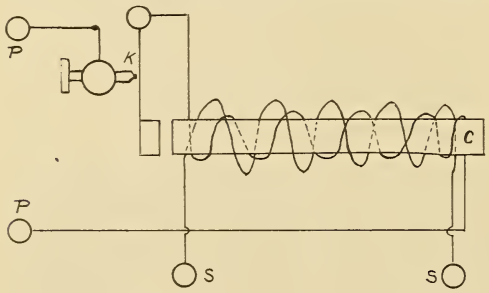


FIG. 1. CIRCUITS OF A "SHOCKING" COIL

from one of these simple coils and a few cells of dry battery than from many a costly toy, and the youthful experimenter will find in its making instruction in some of the fundamental principles of the application of electric current. The following

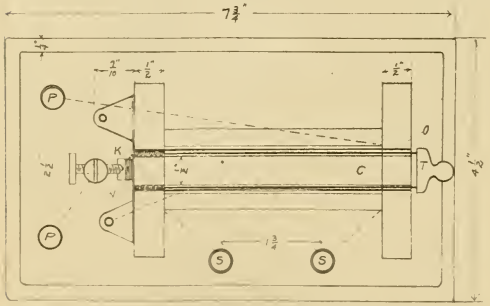


FIG. 2. PLAN VIEW OF "SHOCKING" COIL

description tells just how to proceed in making one.

Fig. 1 shows circuits and connections necessary in the construction. Connections from the battery or other source of energy are made at (PP). The secondary wires are taken off at (SS), (C) represents the core, and (K) the "make and break" device. The same letters refer to like parts in Figs. 2 and 3. Dimensions and explanations of parts of the device that may be arranged to suit the fancy of the builder are omitted.

For the core (C) soft iron wire No. 20 to No. 24 B and S gauge may be used. Anneal the wire first by placing it in a coal or coke fire about ready to die down. Sandpaper the oxide from the wire when cool, dip in hot water, dry with a cloth and then paint with thin shellac. Now cut the wires into lengths 4¾ inches long. Into any metal tube three inches long, having a smooth inner surface force as many of these wires as possible. Where the wires extend from the ends of the tube make them even, bind them about with a wire and dip the ends into melted solder. The bundle may be held tightly together at the middle after removal from the tube by binding with several turns of stout linen thread. Schellac again with a thin coat.

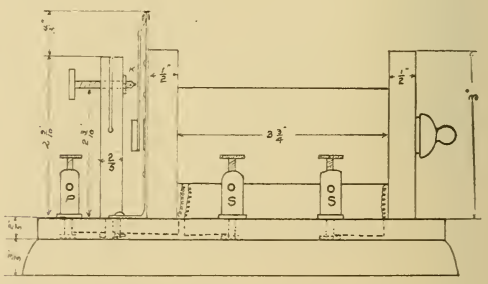


FIG. 3. SIDE VIEW OF "SHOCKING" COIL

Referring now to Figs. 2 and 3, provide four pieces of good close grained wood (see dimensions), two pieces for uprights to support the ends of the coil, and two pieces for the base. Note on the upper base that binding post nuts are counter sunk in it and also that the wires are run

through holes to its under side and follow grooves provided. After the coil is complete, the lower base may be fastened to the upper by small wood screws, small holes being drilled first to prevent cracking the wood.

Returning again to the core, provide a hard rubber collar (N), $\frac{1}{2}$ inch wide, 1-16 inch thick, and just a little larger than the core. On the end of the core wind a $\frac{1}{2}$-inch strip

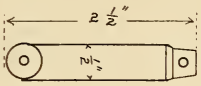


FIG. 4. INTERRUPTER SPRING

of light manilla paper soaked with flour paste, and over this slip the rubber ring indicated in Fig. 3 by the cross lines. If rubber is not at hand, this collar may be made of paper. Next provide a paper cylinder, Fig. 3 (O), just large enough to fit the collar (N) when pasted as shown. This cylinder should be $4\frac{3}{4}$ inches long, and may be made by winding paper of the above

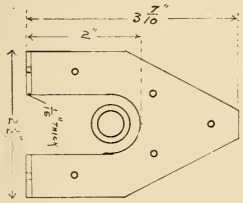


FIG. 5. INTERRUPTER SPRING SUPPORT

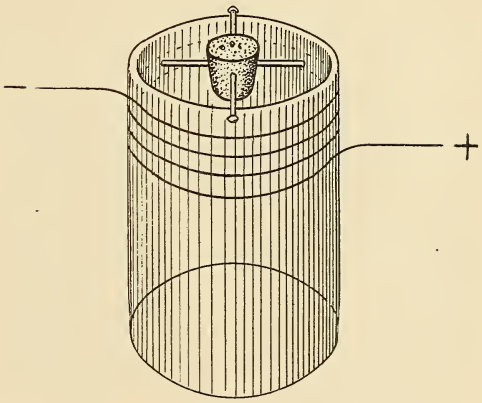
width ($4\frac{3}{4}$ inches) upon a metal cylinder just large anough to slip tightly on collar (N). This paper should be saturated with paste, slipped off the cylinder and allowed to dry in cylindrical shape. When dry slide this cylinder over the core and collar (N), after sliding the copper or brass tube (T) up to the rubber collar. This tube (T) may be moved back and forth by its wooden handle thus cutting off the effect of the primary current on the core and increasing or decreasing the shocking effect. The whole, core, paper tube and sliding tube, may now be fitted into $\frac{1}{2}$-inch supporting blocks, and plenty of glue or paste applied.

Over the paper cylinder wind two layers of No. 22 single cotton covered wire, soaked in paraffine, for the primary coil, bringing the wires out at the ends as indicated in Fig. 2. Cover the primary with a layer of stout paper and schellac in place. Now wind on $\frac{3}{4}$ of a pound of No. 36 double cotton covered wire, paraffined, bringing the terminals out as shown in Figs. 2 and 3. Silk covered wire may be used if preferred, without paraffine. The interrupter screw (K) should be platinum tipped. The spring, Fig. 4, may be of thin German silver or steel, with a soft iron disk riveted to the end. The interrupter spring support, Fig. 5, may be of 1-16-inch sheet brass. Use four volts of battery, or about three cells in series. Brass tubing soldered to flexible drop cord may be used for handles.

Simple Current Detector

To make a simple current detector, wrap several turns of about No. 26 insulated copper wire around the top of a glass tumbler in the manner shown in the sketch.

Next procure a cork, and having ascertained the centers of the ends with a compass thrust two brass pins in them. Magnetize a sewing needle and put it through the cork



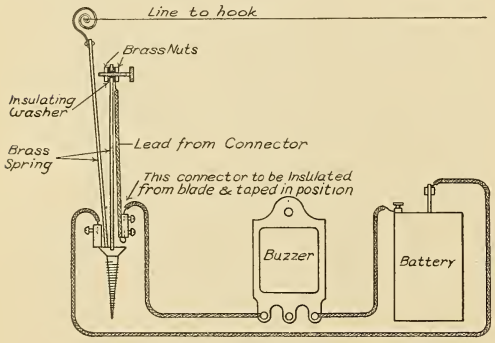
SIMPLE CURRENT DETECTOR

at right angles to the pins so that it balances in a horizontal position. Notch the glass at two opposite points, put a drop of oil in each notch, and rest the pins in them. When a current goes through the wire the needle will dip. The needle should be kept pointing in an east and west position.

This device should only be used to detect weak currents, as from dry cell batteries. It must not be used across 110 volt mains unless an 110 volt lamp be connected in series with the coil or else wire of sufficient resistance be used in the coil so as not to throw a short circuit on the line.

Fishing Signal

Following is a description of a unique fishing signal which may be rigged up on a wharf or pier, and so arranged as to operate an electric bell or buzzer, located in the fisherman's cottage or any other place desired, whenever a fish pulls upon the line. All that is necessary to make the device are two pieces of spring brass or old hack saw blades, one about six inches and the other about seven inches long, a



FISHING SIGNAL

large flat head screw, two wire connectors, one dry battery, a piece of ⅜-inch fiber bushing and fibre washers, adjusting screw and nuts, some rubber insulated wire and a bell or buzzer.

First set the screw in place on the wharf and solder the six-inch piece in place in the slot and solder the seven-inch piece and one of the connectors to the top of the screw head at the left as shown. The seven-inch piece should slant away from the six-inch piece.

The six-inch piece, before it is soldered in place, should have a ⅜-inch hole drilled near the top in which should be placed the bushing. On each side of the hole are the fibre washers, followed up by the adjusting screw and nuts as indicated in the diagram. The adjusting screw is therefore insulated from the six-inch piece.

The other connector is fastened near the lower end of the six-inch piece by tape and is insulated from it.

A piece of spring brass may be fastened to the top of the seven-inch piece and made into the form of a spiral to which the fish line is fastened.

If the apparatus be set up with the head of the adjusting screw toward the water, and a fish pulls upon the line, the seven-inch piece is pulled over and touches the end of the adjusting screw. Current then flows from the battery, through the left hand connector and seven-inch piece, through the adjusting screw, down through the insulated lead to the right hand connector, on through the buzzer to the other side of the battery, completing the circuit and operating the buzzer.

Laminated Motor on Alternating Current

Laminated-field motors designed for direct current, such as the one described in the May, 1909, issue of Popular Electricity, page 46, will operate on alternating current, since the polarity of both the field and the armature terminals reverse with each reversal of the alternating current. Operated by alternating current they are, however, less efficient, owing to the great self-induction in the fields. Still with plenty of power available, as from an alternating current lighting circuit, they may be made to run very satisfactorily. In regard to this, A. W. Jefts, of 6 Hudson street, Worcester, Mass., writes as follows:

"In the May issue of Popular Electricity there appeared plans and details for a small battery motor with laminated fields and laminated armature of three coils. I call your attention to it for the reason that it may interest some of your readers to know that, while the motor was designed to run on direct current from two to four dry batteries, which it does very nicely, it will run like a whirlwind on alternating current of 104 to 110 volts, 60 cycle, single phase; this by simply putting it in series with a 32 candlepower lamp. Connected in this way it was very strong. With a 100 candlepower lamp in series it is a little giant and would make an excellent fan motor, easily made and of little cost.

"The one I have made cost me 40 cents for material. I made changes in the design, making it a little heavier, by using thicker laminations and more wire on both field and armature windings.

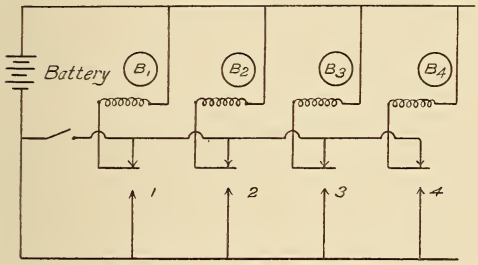
"The details were somewhat simplified. It is self-starting on alternating current and is more unique than the originator seemed to know. I will give working details to anyone interested enough to write for them."

QUESTIONS AND ANSWERS

Readers of Popular Electricity are invited to make use of this department. State your questions as clearly and concisely as possible. No consideration will be given to communications which do not contain the full name and address of the writer

More Doorbell Engineering

The question of how to ring four doorbells from a fifth push button and still have the bells all work independently has brought in a long train of solutions. Some were wrong, some too expensive, and some unmen-



FOUR BELLS RUNG FROM A FIFTH BUTTON

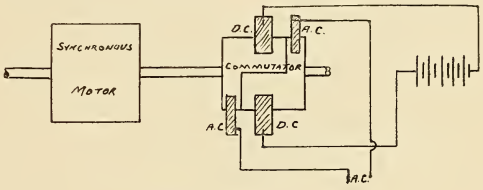
tionable. But a doorbell engineer comes along with the only real, up-to-date, Twentieth Century method of attacking this "complex" problem. The diagram shows how it should be done. Connect the back contacts of all the bells to the middle wire, which contains the fifth push button.

The discussion will now be considered closed, and further reference to this particular problem will result in a waste of postage stamps.

Pole Changer for A. C. to D. C.

Question.—Would you kindly advise me if such an arrangement as is sketched here would change A. C. to D. C. on a non-conductive load such as storage battery charging, also if it would work on an inductive load.—C. E. H., Jr., Chicago, Ill.

Answer.—In the diagram, which we reproduce, you state that the synchronous motor runs at half frequency speed by gearing, which is impossible, as the speed must depend upon the number of poles of dynamo and motor. The commutator device might be so geared. Your device would not work at half speed because if the dynamo were only bi-polar, which is unlikely, the current would change in direction once during each revolution and hence the commutator would have to run at exactly the same speed. If the dynamo is multipolar your commutator will have to run as many times faster than the dynamo as there are pairs of poles on the dynamo. If



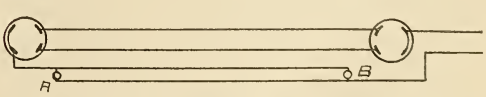
POLE CHANGER

the dynamo is twelve-poled the commutator will have to run six times as fast as the dynamo. Also, the D. C. brushes will have to be set so that they are passing from one commutator bar to the other when the A. C. current is at zero. Exact synchronism must be maintained. You will find that this device is generally impractical. The current it would produce would be pulsating and not smooth, and while it can be used on battery charging it will act upon inductive loads much as an alternating current would, but not to so great an extent.

Controlling Lights from Two Points

Questions.—(A) Will you explain to me by diagram how to wire two lights and switches so as to turn on light from downstairs and shut same off by switch upstairs. (B) Can two lights be on the same switch, one downstairs, and one in the hall, to be turned on upstairs and shut off downstairs? —A. S. L., West Point, Cal.

Answers.—(A) The better way is to use two three-point switches, one upstairs and one downstairs, wired as shown in the diagram.

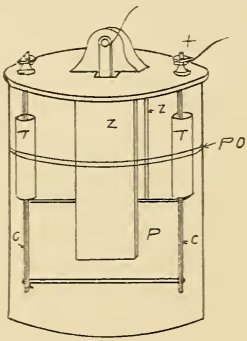


(B) The two lights may be separated, (A) being in the hall and (B) downstairs.

Edison Cell

Questions.—(A) Please explain the construction of an Edison cell. (B) Does this cell wear itself out when not in use? (C) Should it be kept on a closed circuit when not in use? (D) What is the voltage of this cell? (E) Will a common earthen jar of proper dimensions be suitable for this cell? (F) How long will this cell last with ordinary usage?—W. W., Colorado City, Colo.

Answers.—(A) Magnesium chloride mixed with cupric oxide is molded under pressure into a plate of the required weight and size. Heating this plate binds the mass together.



EDISON CELL

Referring to the drawing, the cupric-oxide plate (P) is shown suspended by a copper frame (C) protected in the electrolyte above the plate where the rods run to and through the cover, by porcelain tubes (TT). One of these copper rods from the frame is used as a binding post for the positive lead (+). Supported through the cover are two zinc plates (ZZ) between which is suspended the cupric oxide plate. A bolt and binding post connects the two zinc plates and is the negative lead (—) connection. A thin layer of paraffin oil (PO) is used to cover the electrolyte and adds one-third to the life of the cell. The 300-ampere cell is 10 inches high by 6¾ inches in diameter. The cover of the jar should preferably be of porcelain. The internal resistance of the cell is about .03 ohm. This cell will give 12 or 14 amperes but runs most efficiently at six amperes. For the 300-ampere hour cell the copper-oxide plate should weigh at least two pounds. To set up the cell, place water in the jar and into this sprinkle granulated potash, stirring the solution until the potash is all dissolved and the solution is "saturated." Next put the plates in place and pour on the heavy paraffin oil. Be careful that the surface of the electrolyte is at least one inch above the oxide plate.

(B) No.

(C) No.

(D) .7 of a volt.

(E) Yes.

(F) That will depend upon the output required and also upon the size of the plates. The cell is built to give as high as 900-ampere hours being then used for lamps and small motors.

Grounded Telephone Lines

Questions.—(A) How may cross talk on grounded party lines be eliminated where such lines parallel on the same line of poles for four or five miles? Would running an extra wire for each line and grounding it beyond the point of intersection and transposing these wires the same as for a metallic circuit be any benefit? (B) Will a grounded line carry more telephones and give getter service than a metallic line when there are no other lines paralleling? (C) How would you compute the resistance of a grounded line 10 to 12 miles long with 16 and 17 bridging telephones equipped with 1600 ohm ringers and what allowance should be made for each bell added to or removed from the line? Lines are constructed of No. 12 and No. 14 E. B. B. galvanized iron wire. (D) Please inform me how to solder galvanized iron wire to a galvanized ground rod, with a torch or copper.—W. M., Mapleton, Minn.

Answers.—(A) There is no possible method of preventing cross talk on grounded lines, while they remain grounded lines, especially when of such length, and you must resort to some method of making them metallic at least for the length that they are paralleling. It is best to make them metallic their entire length. Running an extra wire as you suggest would do no good and would probably aggravate matters by

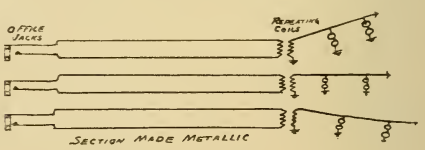


FIG. 1

producing extra grounds. If the lines extend for several miles beyond the point of intersection, making it too costly to run metallic circuits and the lines diverge materially, the method shown in Fig. 1 will help you out. Briefly make your lines metallic as far as possible, at least as far as they parallel, and connect to repeating coils as shown, grounding one side of the re-

peating coil. Be sure and keep the metallic ends of these lines free of grounds. The method shown in Fig. 2 has been used successfully where two grounded lines parallel for a short part of their length only.

FIG. 2

(B) No, there is no excuse whatever for running grounded lines except cheapness, and it is impossible to free grounded lines from noises and induction. When the trolley and power wires begin to parallel your leads, you will find conversation impossible on your grounded lines, and even the changing magnetic field of the earth or storms will make your line noisy.

(C) Use the formula,

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}+\frac{1}{R_5}+\cdots\frac{1}{R_{17}},$$

where R is the total resistance of the line, R1, R2, R3, etc., the resistance of each individual telephone plus the resistance of the line from the office to the telephone. The resistance of No. 14 E. B. B. galvanized iron wire is 49.08 ohms per mile; of No. 12 is 28.46 ohms. The resistance of the earth can be neglected, it depending mostly on the resistance of your ground connections. The reciprocal of the above formula is the one generally in use. Roughly the resistance of your line will be the resistance of each bell divided by the number of bells, plus the line resistance to the first telephone if the remaining telephones are fairly close together. You can easily figure out for yourself the effect of adding to or taking away telephones by the formula.

(D) You should have no difficulty in soldering galvanized iron. First clean the rod and wire, taking care not to scrape off the galvanizing. Then wrap the wire tightly around the rod in a spiral with convolutions about $\frac{1}{8}$ inch apart. Heat the rod with a blow torch, not on, but near to the joint to be soldered, until the joint is hot enough to melt wire solder. Apply a good soldering flux (one made by adding an excess of zinc to muriatic or hydrochloric acid is best) and then work the solder into the joint until it flows freely. Be sure and wash off the excess of acid or it will corrode the joint. A quicker way, if you have a large number to solder is to dip the joint into a pot of hot solder instead of using the torch. A soldering iron is not practical for such large work. The main point is to get the rod hot.

Telephone Phantom Circuits; Telephone Pole Changer

Questions.—(A) Show by diagram and explain a phantom circuit on a telephone line. (B) Show diagrams of a telephone pole changer and tell how it works.—A. A. R., Glasgow, Mo.

Answers.—(A) A phantom telephone circuit employs the wires of other telephone circuits for its operation, and properly installed and equipped is as efficient as the

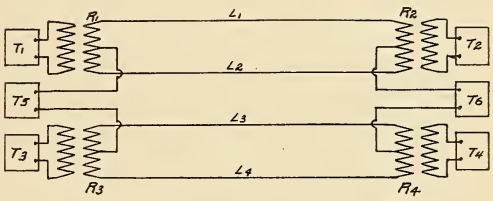


FIG. 1. A PHANTOM CIRCUIT

circuits of which it is composed, and none of the circuits interfere with each other. There are several methods of connecting up a group of wires so that more telephones can be served with metallic circuits than there are pairs of wires, but the diagram shows the standard phantom arrangement for obtaining one phantom from two metallic circuits. In Fig. 1 (L1), (L2), (L3) and (L4) represent the wires of two metallic telephone circuits of any length connecting telephones (T1) with (T2) and (T3) with (T4) through repeating coils (R1), (R2), (R3) and (R4), as indicated. These repeating coils are similar to ordinary induction coils or transformers with primaries and secondaries of equal resistance and with a closed magnetic circuit. A connection is brought out from the exact center of the secondary or line side of each repeating coil. Telephones (T5) and (T6) connected to these connections will operate over a phantom circuit and we thus have three non-interfering, metallic telephone circuits operating over four wires. The current from telephone (T5) passes to the center of coil (R1) and divides equally, half going over (L1) and half over (L2) to the outsides of coil (R2) and uniting at its center to telephone (T6), thence back in a similar manner through coil (R4), line wires (L3) and L(4) and coil (R3) to (T5), thus

completing the circuit. Since the current divides and travels in opposite directions in the line side of the repeating coils it has no effect on their primaries and therefore does not disturb the other telephones. Similarly it will be seen that the current from the telephones (T1), (T2), (T3), and (T4) cannot pass out through the central connections of the repeating coils and therefore cannot interfere with the phantom.

For successful operation it is necessary that the lines must be similar in every respect and the repeating coil resistances, etc., be exact, so that the currents will divide evenly and the phantom circuit must be treated and transposed similarly to the other circuits.

(B) The ordinary pole changer consists of a pendulum (P) Fig. 2 fastened at one end and caused to vibrate by means of an electromagnet (M) operated by the battery (B), the same as an ordinary doorbell

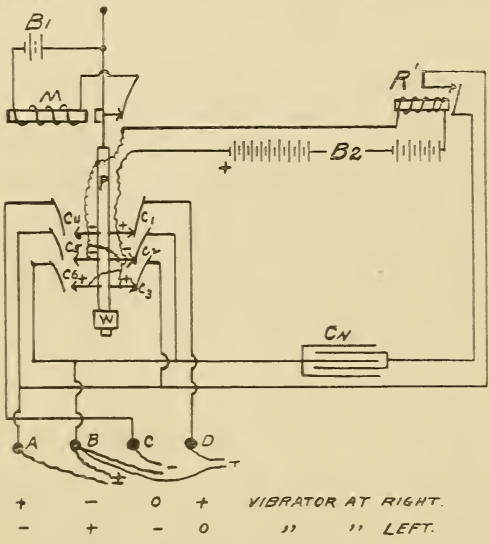


FIG. 2. THE ORDINARY POLE CHANGER

operates, and arranged to make connections to a ringing battery. The period or frequency of this pendulum is regulated by its length and the adjustment of the weight (W). The pendulum carries, at its lower end, contacts (C1) to (C6), which are connected to the ringing battery (B2) as indicated, and in vibrating alternately make contact with the spring contacts indicated on each side of the pendulum. The spring contacts are connected to the line terminals (A), (B), (C) and (D). The battery (B1) is a closed circuit battery designed to keep the pendulum operating continuously, which requires very little power. The battery (B2) is in circuit only while ringing and generally consists of sufficient dry batteries to deliver 75 to 85 volts on the line. Connecting to posts (A) and (B) will give alternating current and to posts (B) and (C) and to (B) and (D) will give negative and positive pulsating current respectively. In series with battery (B2) is a relay (R) which throws the condenser (C) across the line when ringing so as to smooth out the pulsations. The pendulum is shown thrown against the right hand contacts and by tracing the circuits from the battery it will be seen that (A) and (D) are positive and (B) negative, (C) being open. With the pendulum to the left (A) and (C) will be negative and (B) positive, (D) being open. Thus (A) and (B) are alternately positive and negative; that is, we obtain alternating current between them.

Transposing Telephone Phantom Circuits

Question—How can I transpose telephone lines for phantom circuits?—E. B., Chico, Cal.

Answer.—You do not state any specific phantom system or the number of lines to be transposed, but in general you will

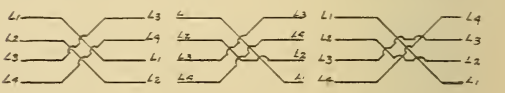


FIG. 1 FIG. 2 FIG. 3

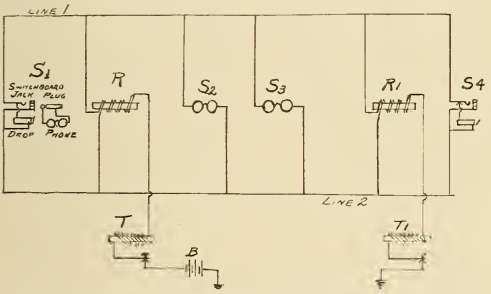
transpose successfully if you treat the phantom circuits as separate metallic circuits. The component parts of the phantom should always occupy adjacent pins on the cross arm and should be of the same kind and size of wire. Considering the phantom described in the answer to A. A. R. it can be seen that there are three ways of transposing a phantom composed of four wires. In Fig. 1 neither metallic circuit is transposed. In Fig. 2 (L1) and (L2) are transposed. In Fig. 3 all the lines are transposed. Fig. 4 shows a section of transpositions to prevent cross talk between two metallic circuits and one phantom.

FIG. 4

Telegraph and Telephone Circuit on Same Wires

Question.—We have a toll line that is 40 miles long, of two No. 9 iron wires, that has four drop and jack stations on the line, and expect to duplex it for telegraphing from station No. 1 to station No. 4. Please explain by diagram how this can be done and how many coils will have to be used.—H. C. E., Boone, Ia., also T. G., Brockwayville, Pa.

Answer.—The accompanying diagram will give you the information sought. We assume that the line runs through each station and cannot be cut in two at the intermediate stations. (S1), (S2), (S3) and (S4) represent the stations on the line. (R) and (R1) are impedance coils, split with two equal windings, and connected across the line. The telegraph instruments are connected between the central connection of these impedance coils and the ground as shown. These impedance coils are best made by



COMBINED TELEGRAPH AND TELEPHONE CIRCUIT

winding two wires of about No. 30 B. & S. gauge wire in parallel, around a bundle of soft iron wires, to about 150 ohms resistance for each wire and then bending the ends of the iron wires back over the coils so as to cover them and make a closed magnetic circuit. Care must be taken to insulate the wire properly and to bring out the four connections as shown. The ordinary coils of a bridging bell may be often used by connecting the coils directly across the line and connecting the telegraph instruments at the point where the coils are connected together. Pieces of soft iron should be fastened between the poles of the iron cores so as to make a complete magnetic circuit, or often two magnetically wound resistance coils may be connected in series across the line and the tap for the telegraph taken out between them. In all cases the coils and the line wires must be of equal resistance so that an equal current will flow over each side of the line, otherwise the telegraph impulses will be heard in the telephone receivers. If the lines are not equally balanced they should be overhauled both for the sake of good telephone as well as telegraph service. If the telegraph clicks are heard on the telephones it may be necessary to bridge condensers across the telegraph keys so as to smooth out the telegraphic waves. These condensers may be from 2 to 12 microfarads capacity depending upon conditions. The batteries used with the telegraph instruments should be of the closed circuit type (gravity) and the number of cells determined by experiment.

Transformer Theory

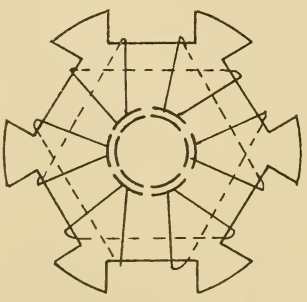
Question.—A static transformer with its primary circuit connected to the mains of an alternating dynamo, and its secondary circuit open, or disconnected from any load, takes from the mains supplying it, very little current due to self-induction, that is, there is only enough current flowing in the primary when the secondary is open to set up the magnetic flux which in turn produces a current which is equal to, and opposite in direction of flow to that of the current supplied by the mains from the alternator. Now the opposing or induced current allows little current from the mains to flow in the primary circuit when the secondary is open. This being true, why is not this self-induction effect produced in the telephone receiver and secondary of the induction coil of the party listening, as well as the receiver of the party talking? It appears that this effect of self-induction would be present and sufficient to allow little or no current, or at least not sufficient current, to flow in the circuit to operate the receiver of the listening party. —J. C. S., Jefferson, Ia.

Answer.—Your statements are all true, but only as generalities. You must understand that self-induction and impedance and resistance are only relative terms. There is no self-induction in any coil until there is current and this of a varying nature flowing through it. An impedance coil used upon a direct current loses its identity and becomes merely a resistance coil. Also when this coil is used on an alternating current, some current must pass through the coil in order to produce magnetization of the core, self-induction between the convolutions and the other factors which go to make up impedance. This current is called the magnetizing current in transformers and depends upon the design of the coil, frequency of the current, etc., but is always present whenever a voltage is impressed upon a coil. When a current flows in the secondary of a transformer it has an action (demagnetizing) to counteract the effects of the primary current and therefore more

current must flow in the primary to produce the proper inductive effect upon the secondary and this is exactly what happens. The whole idea that you should gain, however, is that, no matter what the conditions, some current will flow through a coil if there is a voltage impressed upon it. The quantity of this current depends upon the design of the coil, frequency of current, etc., other things, such as voltage, being equal. The problem of the receiver and induction coil secondary is therefore to produce an impedance effect so that there will be at least enough magnetizing current flowing in the receiver to produce the proper effect upon the diaphragm, i. e., a problem of design which has been admirably solved. When you consider how little current is actually required to operate a telephone receiver you will gain an idea of the meaning of the word design as here used. If it required more power, the receiver coils would have to be wound so as to absorb more magnetizing current. The effective current in a telephone receiver is generally so small that it cannot be measured by ordinary means. In many common battery systems most of the current passing through the receiver is direct and has practically no effect upon the sound.

Winding a Six Slot Armature

Question.—How should a six slot armature be wound and connected.—H. L., Chicago, Ill.



WINDING A SIX SLOT ARMATURE

Answer.—The diagram shows one way of doing this, each coil occupying one-half the depth of the slot.

Soldering Flux; Melting Zinc; Resistances of Iron and Steel Wire

Questions.—(A) Can you tell me how to make a soldering paste or flux that will be equally effective on brass, copper, zinc and iron? (B) How can zinc be melted? I have been told that it would run into the pores of a crucible. Is this so? (C) Will you give a table of the resistance of iron and steel wire?—E. M. C., Rocky Ford, Colo.

Answers.—(A) Place chips or filings of zinc in strong hydrochloric acid until a saturated zinc chloride is obtained. Add one-third spirits of sal ammoniac and one-third rain water and filter. This flux will leave no rust spots on iron and steel. To solder zinc, the zinc chloride should be used without the sal ammoniac.

(B) Use an earthenware crucible such as is used in making alloys of different metals. The trouble you speak of we have not been able to verify.

(C) Roebling gives the following table:

No. B. W. G.	Dia. Mils	Weight 1000 feet	Res. per Mile in Ohms		
			E. B. B.	B. B.	Steel
0	340	304	2.93	3.42	4.05
1	300	237	3.76	4.4	5.2
2	284	212	4.19	4.91	5.8
3	259	177	5.04	5.9	6.97
4	238	149	5.97	6.99	8.26
5	220	127	6.99	8.18	9.66
6	203	109	8.21	9.6	11.35
7	180	85	10.44	12.21	14.43
8	165	72	12.42	14.53	17.18
9	148	58	15.44	18.06	21.35
10	134	47	18.83	22.04	26.04
11	120	38	23.48	27.48	32.47
12	109	31	28.46	33.3	39.36
13	95	24	37.47	43.85	51.82
14	83	18	49.08	57.44	67.88
15	72	13.7	65.23	76.33	90.21
16	65	11.1	80.03	93.66	110.7
17	58	18.9	100.5	120.4	139.
18	49	6.3	140.8	164.8	193.8

Grades of wire as referred to by letters in the above table have the following properties: "E. B. B." is a very soft, high grade material, having the highest conductivity of all. Its breaking strength is three times its weight per mile. "B. B." wire is better mechanically and has a breaking strength of 3.3 times its weight per mile. "Steel" wire is the strongest, its breaking strength being 3.7 times its weight per mile, but it is lacking in conductivity. This wire is the cheapest, is used much for telephone work on short lines, and Miller states that as far as talking results are concerned on such lines no difference can be noted between the use of an iron, steel or copper circuit.

Galvanized Iron for Motor Laminations

Question.—Could galvanized iron be used for the laminations in an alternating current motor? —J. D., Cleveland, O.

Answer.—No. The iron is not soft enough. It would cause too great a core loss in the motor. Also the plates would not be insulated from one another and would allow eddy currents to flow through, causing heating and other loss.

The Fuller Cell

Questions.—(A) Explain the construction of a Fuller cell. (B) If purchased, what would one cost?—D. S., St. Paul, Minn.

Answers.—(A) The Fuller cell is a two-fluid one. It consists of the following parts: Provide a glass jar similar to one used for any fluid or gravity battery. Next secure a porous cup of nearly the same depth as the glass jar, and having one-third of the latter's capacity. Get a rod of zinc and secure to its end a lump or cone of the same metal. The upper end of this zinc rod is one terminal of the cell. Outside the porous cup and in the glass jar suspend a carbon block having a connecting terminal at its top. The cover of the jar may be of any non-conducting material and so constructed as to hold the upper end of the zinc rod and also the carbon plate. To set the cell up, pour a little mercury into the porous cup, then put the zinc electrode in place. Now fill the porous cup nearly full of very dilute sulphuric acid. In an earthen jar make the following solution called "electropoion:"

Bichromate of potash or sodium bichromate	3 parts
Sulphuric acid	1 part
Water	9 parts

The bichromate is best prepared by adding it to hot water, to which, when cool, should be added sulphuric acid very slowly.

To hasten the action of this cell a teaspoonful of salt may be dissolved in a pint of water and a little of this added to the porous cup solution.

This cell gives two volts and for a considerable time 0.6 of an ampere. Its internal resistance is from one-half to one ohm.

(B) See manufacturers' catalogues.

Batteries

Questions.—(A) What solution is used in an Edison primary battery? (B) What is the difference between a primary and a secondary battery? —S. P., Morristown, Pa.

Answer.—(A) The electrolyte is a solution of potassium hydrate.

(B) A primary battery converts chemical energy directly into electric energy, while a secondary battery is made up of such materials that when they undergo chemical action due to the current being sent through the cell. This cell then acquires the properties of a primary cell, and if its external circuit be closed is capable of giving back the original charge.

Tesla Coil for X-Ray

Questions.—(A) In the high frequency apparatus in the March issue, (answer to E. H. B., Brooklyn) I wish to ask whether this coil can be used for X-ray purposes? (B) If this coil will perform the experiment on page 162 in July issue? (C) Can I use No. 35 wire in place of No. 31, and if so, what would be the effect? (D) How can I build a fluoroscope?—T. R. F., Pryor Creek, Okla.

Answers.—(A) Yes.

(B) No.

(C) Yes, but the Tesla coil would have to be varied to suit the change in the induction coil or transformer, as the coil voltage would be greater but the current less. Therefore a smaller condenser would have to be used, and the Tesla coil wound to suit the condenser. The induction coil described would require more careful insulation between secondary and primary if No. 35 wire were used as the voltage would be greater.

(D) To make a fluoroscope take a sheet of paper or other substance transparent to X-rays and cover it with a fluorescent substance such as tungstate of calcium or platino-barium-cyanide. Mount it in the large end of a stereoscope with the fluorescent surface turned toward the inside.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM. By Silvanus P. Thompson. Chicago: Thompson & Thomas. 1906. 499 pages with 193 illustrations. Price $1.50.

The sciences of electricity and magnetism are based on exact laws determined through laborious experimental work performed by generations of indefatigable workers. To afford the beginner in electricity a clear and accurate knowledge of these fundamental and epoch making experiments is the object of the book; and it fulfils the requirements admirably. Three distinct sets of phenomena are observable at the outset—frictional electricity, current electricity and magnetism, and accordingly the first three chapters are devoted to an exposition, in "Plain English" of the prominent experimental facts of these three branches of the subject, reserving for the later chapters the points of connection between them, and such parts of electrical theory as are admissible in a strictly elementary work.

A series of exercises and problems has been added at the end of the book in order to enable students, when they so desire, to test their power of applying thought to what they read, and to ascertain how far they have digested the matter contained in the text.

The theory of electricity adopted throughout the lessons is that whatever may be its true nature it is *one*, not *two:* whatever it may prove to be, it is not *matter*, and is not *energy;* that it resembles both matter and energy in one respect, it can neither be created nor destroyed. It conforms, therefore, to the great doctrine of the conservation of matter, established a century ago by Lavoisier, and to the doctrine of the conservation of energy built up by such great scientists as Helmholtz, Thomson, Joule and others,—which teach that we cannot create or destroy energy or matter, although we may cause them to change from one form to another.

Modern Electric Railway Practice. Volumes 1, 2, 3 and 4. By Sidney Alymer-Small, Calvin F. Swingle and Paul E. Lowe. Chicago: National Institute of Practical Mechanics. 1909. 831, 709, 713 and 676 pages respectively, with 433, 356, 368 and 58 illustrations respectively. Price $25.00 per set.

With this work at hand it would be hard to find a phase of electric railroading, as far as the electrical equipment is concerned, upon which exact and practical information would not be immediately forthcoming. This information is not a rehash of material which is out of date through the rapid advance of electric railway development, but is practically up to the minute as far as a textbook can be made. To attempt to outline the scope of this work fully would be to write another small book, but the following will give an insight into contents of these four large volumes, which, by the way, are beautifully bound and an ornament to any library.

Volume I takes up elementary electricity, railway motors and motor control. To obtain a good insight into any subject it is necessary to begin at the bottom, hence the introductory lessons on static electricity, condensers and electrical machines in general. Lightning and lightning arresters are also given full consideration. Transmission lines, feeders, trolley wires and third rails come in this volume and then the various kinds of motors and systems of control now used are reviewed.

In Volume II the air brake is discussed beginning with a full and clearly illustrated description of the Westinghouse A. M. M. equipment for electric traction work; also the G. E., Christensen and others. The electric locomotive is also fully described in all its details.

Power stations, steam and gas engines, and generators and switchboards are the subjects taken up in Volume III. The operation of the various machines is dealt with mainly, rather than their construction and installation. It tells you all about boilers and engines, how to make and analyze indicator diagrams; about steam turbines, railway generators, sub-stations, switchboards, etc.

In Volume IV electric railway troubles are analyzed with a treatment on standard train rules; and, finally, an electrical dictionary.

In each volume there are questions and catechisms to increase the practical value of the work.

It may also be mentioned that with each of these sets goes a certificate of membership in the National Institute of Practical Mechanics, good for one year, during which time the member is privileged to ask questions on engineering which are answered free by the consulting department of the Institute.

Spons' Workshop Receipts. Vol. I. London: E. & F. N. Spon (New York: Spon & Chamberlain). 1909. 518 pages with 223 illustrations. Price $1.50.

This is a condensation and more accessible alphabetical arrangement of the publishers' original "Workshop Receipts." It is for manufacturers, mechanics and scientific amateurs, and this first volume, which only includes names from "Acetylene" to "Drying," contains nearly 2,000 receipts, formulas, mechanical and other processes, etc. Glancing through the pages we find treated such subjects as these: "Baking powder;" "Bell founding and bell metal;" "Bleaching;" "Burnishing;" "Candles;" "Chimney construction;" "Clock and watch mending;" "Distillation;" "Drying and desiccating," etc., which gives a faint idea of the scope of the work. This work complete will be a comprehensive cyclopedia of mechanical and chemical processes.

NEW ELECTRICAL INVENTIONS

Coin-in-the-Slot Curling Iron Heater

Hotel keepers will be interested in the invention of an electric curling iron heater, operated by a coin, which has been patented by Mary M. Buck of Machias, N. Y. The object is to provide means for direction of the current into the heater upon insertion

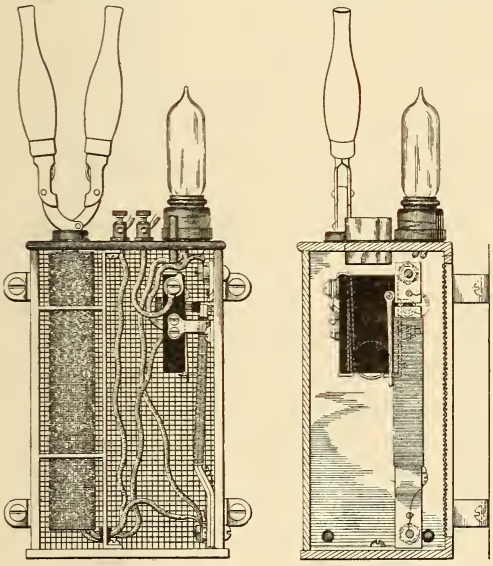


FIG. 1 COIN-IN-THE-SLOT CURLING IRON HEATER

of the coin and to automatically break the circuit when a predetermined length of time shall have elapsed.

Fig. 1 is a side and edgewise view of the interior of the heater. When the curling iron is inserted the tongs are surrounded by the heating coil of fine resistance wire. Current flowing through this coil heats up the wires as in an incandescent lamp filament, which in turn heats the curling iron. To start the current a coin is inserted in the slot which closes the circuit as shown in Fig. 2, the current flowing directly through the coin.

To heat up the iron to the proper temperature will require a certain definite period of time and to release the coin at the end of that period, and so shut off the current from the heating coil, the thermostat shown in Fig. 2 is added. This thermostat consists of bars of dissimilar metal firmly riveted together. These metals have different coefficients of expansion when under the influence of heat, and consequently one will expand more than the other and draw the composite bar into the form of a curve. This curving of the bar releases a little

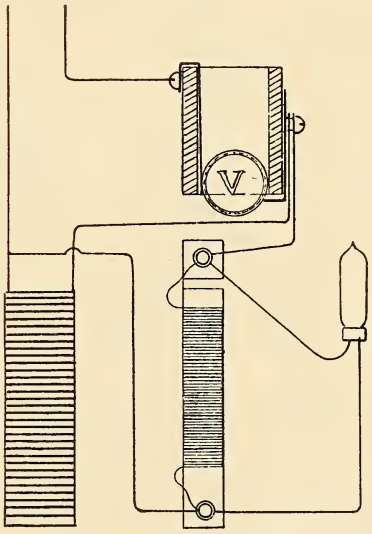


FIG. 2. CONNECTIONS OF CURLING IRON HEATER

catch which allows the coin to drop into a receptacle at the end of the desired period, opening the circuit.

But what causes the thermostat bar to heat up, is asked. This is done by another coil of resistance wire wound around the bar and deriving its current from the main circuit. Current flowing through this coil gradually heats up the bar, slowly enough, however, to give the curling iron time to be heated before the coin is released.

In circuit with the thermostat is a miniature electric lamp which glows as long as the device is in operation. When the circuit is broken by the dropping of the coin the lamp goes out, indicating that the iron is properly heated.

Unique Telephone Attachments

In using the telephone it is oftentimes convenient to have both hands free for making notes, etc. In looking up information, also, it may be necessary to set the receiver down for a moment, which operation sounds to the party on the other end of the line like the clatter of a dozen tin pans.

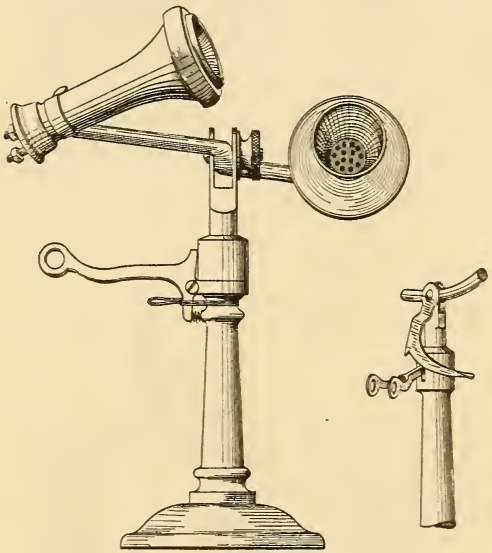


FIG. 1

Two patents have appeared simultaneously on devices for holding the receiver while in use, one awarded to Howard F. Hansell, Jr., of Philadelphia, Pa., (Fig. 1) and the other to Benjamin E. Detrick of New Albany, Ind. (Fig. 2).

In Mr. Hansell's attachment there is a slotted projection above the ordinary desk stand in which are clamped the receiver and transmitter as shown in Fig. 1, the relative positions being such that when the ear is at the receiver the mouth is at the proper position in front of the transmitter. They are held in this position at all times. When not in use the ordinary switch hook must of course be held down to disconnect the telephone, as is the case when the receiver is hung on the hook. The small detail view in Fig. 1 shows how this may be done by means of a small cam lever which is readily released when the telephone is in use.

In Mr. Detrick's device the receiver is held on a swinging bracket arm and normally holds the switch hook down in the disconnect position as shown by the dotted lines in Fig. 2. To use the telephone the arm is swung up as shown, relieving the pressure on the switch hook which signals the central

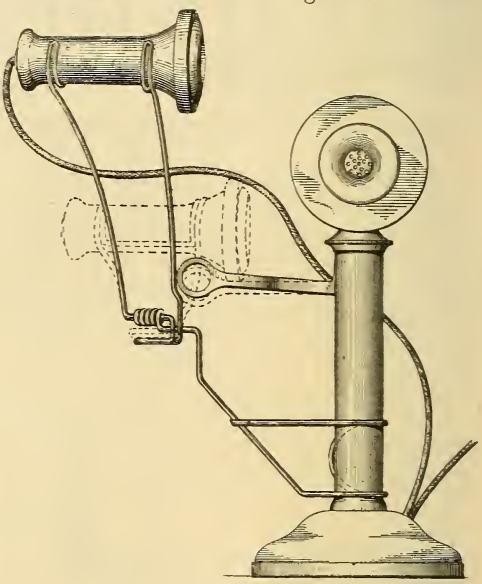
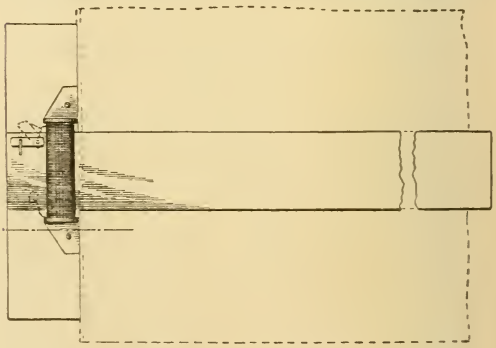


FIG. 2

office. Both receiver and transmitter are then in the proper relative position for use without the aid of either hand.

Magnetic T-Square

The T-square is one of the most important articles in a draftsman's outfit and its adjustment must be perfect in order to do accurate work. James C. Draper and Joseph



MAGNETIC T-SQUARE

W. Reid of Memphis, Tenn., are the inventors of a unique magnetic T-square. The head of the square, which rests against the edge of the drafting board, carries an electromagnet. The edge of the board is provided with an iron strip against which

the pole pieces of the electromagnet rest. Current from batteries or any other suitable source is made to pass through the coil of the electromagnet whenever it is desired to clamp the T-square in a given position. This current energizes the magnet and causes the pole pieces to cling firmly to the iron strip, holding the square in place. If it is desired to move the square about over the board the current is shut off by a simple switch and the magnet thereupon loses its power.

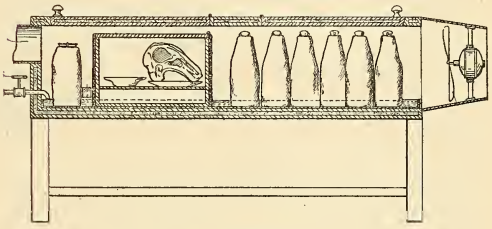
Guard for High Tension Wires

Where high tension light and power wires cross over telephone and telegraph lines there is always danger that the high tension wires may break and fall down on the telegraph or telephone lines and send a dangerous current into the latter. Many kinds of guards have been devised to eliminate this danger, among the latest being that of Charles J. Elliott of Oxnard, Cal. In this invention a rectangle of metal tubing is made to enclose the high tension line and is supported from the pole by suitable brackets. This rectangle is then connected to the earth by a heavy wire running down beside the pole. If one of the high tension wires breaks the end drops onto the rectangle and is grounded before it can touch the telegraph or telephone wires and do serious damage.

Novel Refrigerator

When air, even warm air, is blown over a moist surface, the surface is cooled, sometimes far below the temperature of the adjoining atmosphere. The reason for this is that in the evaporation of moisture a certain amount of heat is required, the same as in the production of steam, and the only place this heat can come from is the body whose surface is moistened. The body therefore gives up its heat and its temperature is consequently lowered.

William A. Merralls of San Francisco, Cal., makes use of this principle in a novel

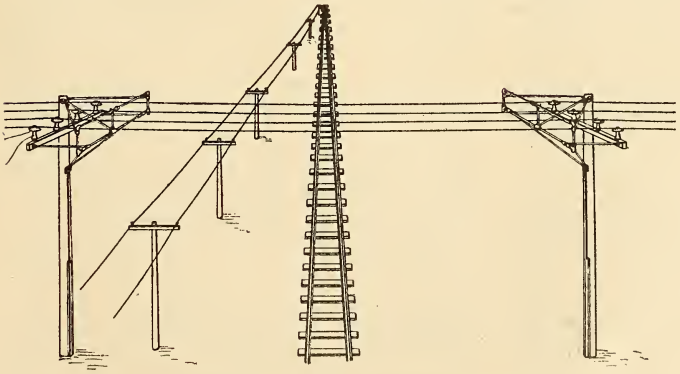


NOVEL REFRIGERATOR

refrigerator. The refrigerator consists of a long, box-like compartment with sides which are non-conductive of heat and the bottom of which contains water. The articles to be cooled, such as milk bottles, little boxes containing food, etc., are wrapped in absorbent material which sucks up water by capillary attraction. In one end of the refrigerator is an electric fan which draws air in from the outside and blows it over all the moist wrappings of the articles in the cabinet and out at the opposite end. This performs the cooling operation, and no ice is required.

Arc Lamp with Disk Carbon

A new and interesting type of arc lamp has been patented in England in which the carbons, instead of being long rods are made in the form of disks. These disks are mounted with their edges almost touching, the arc being formed across the gap. They are also kept constantly rotating so that the carbon is equally consumed at all points. The advantage lies in the fact that the lamps may be made shorter for use where the ceilings are low.



GUARD FOR HIGH TENSION WIRES

Notes on Patent Law

By OBED C. BILLMAN, LL. B., M. P. L.

Regulation of Dealings in Patent Rights and Patented Articles—1. State Regulation. 2. Marking Patented Articles. 3. Marking Unpatented Articles

1. **State Regulation.**—"The right of property in letters patent exists by virtue of federal laws exclusively, and one incident of such right is the right to sell the patent anywhere within federal jurisdiction. Hence it has been declared that state statutes which impose conditions upon the sale of patents, as by requiring the patent to be registered, are unconstitutional and void. Such conditions are regarded as curtailing and nullifying the federal laws, and the imposition of punishment for non-compliance is an attempt to punish the patentee for doing what Congress has authorized him to do."—Ex Parte Robinson 4 Fisher Patent Cases 186; 2 Bliss (U. S.) 314, 20 Fed. Cas. No. 11,932; People vs. Russel, 25 Pat. Off. Gaz. 504.

"Emphasis has been laid upon the distinction between control of the letters patent and control of the patented articles. It is generally recognized that as properly patented articles are not under federal jurisdiction, and may be subjected to control and taxation by the states, so far as such control is not repugnant to other recognized principles of law." Patterson vs. Kentucky, 97 U. S. 501. State vs. Bell Telephone Co., 36 Ohio St. 296.

2. **Marking Patented Articles.**—It is the duty of the patentee or of his assigns and legal representatives, and of all persons making or vending any patented articles for or under them, to give sufficient notice to the public that the same is patented, either by fixing thereon the word "patented," together with the day and year the patent was granted; or when, from the character of the article, the word "patented" cannot be so affixed, by fixing to it or to the package wherein one or more of them is inclosed a label containing the like notice.—U. S. Rev. Stat. Sec. 4900. Sessions vs. Romadka, 21 Fed. Rep. 124.

Penalty for Failure to Mark.—The penalty prescribed for failure to comply with this rule is that in a suit for infringement no damages shall be recovered by the party failing so to mark the articles, except on proof that the infringer was notified of his infringement and continued, after such notice, to make, use, or vend the patented article.—U. S. Rev. Stat. Sec. 4901; and Goodyear vs. Allyn 10 Fed. Cas. No. 5,555. "When an article contains such mark an infringer is liable although ignorant of the existence of letters patent."—Hogg vs. Gimbel, 94 Fed. Rep. 518.

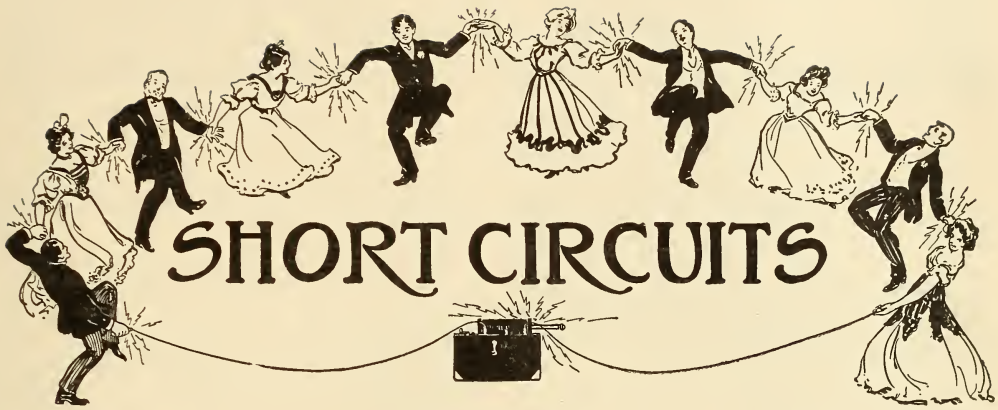
3. **Marking Unpatented Articles.**—"Any one who, having no patent therefor, marks an article with the name of any person who has a patent, or who affixes an imitation or counterfeit of a patented device or affixes the word "patent" or its equivalent to an unpatented article, is liable to a penalty of not less than one hundred dollars with costs; one-half to go to the informer, the other half to the United States, to be recovered by suit in any district court of the United States, in whose jurisdiction the offense was committed." U. S. Rev. Stat. Sec. 4901.

"The intention to secure a patent subsequently does not excuse the offense, if it was intended to deceive the public." Stephens vs. Caldwell, 22 Fed. Cas. No. 13,367.

Marking Patent Applied For.—After application for a patent the article may be stamped "patent applied for," and the word "patented" may be affixed when the patent has been allowed but not issued.—Schwebel vs. Bothe, 40 Fed. Rep. 478; Lauferty vs. Wheeler, 11 Daly (N. Y.) 194.

Marking After Patent Expires.—"The word 'patented' may be affixed to an article after the patent has expired, since the public is presumed to know from the date that the patent has expired."—Wilson vs. Singer Mfg. C.o, 11 Biss (U. S.) 298.

Restraining Disclosure of Secret.—The state court may, at the instance of the inventor or discoverer, restrain a person from divulging the secret of an unpatented device or improvemant.—Hammer vs. Barnes, (Supreme Court Spec. T.) 26 How. Pr. (N. Y.) 174.



Knicker—How long does your wife plan to be away?
Bocker—Two trunks.

* * *

Pat—I hear your woife is sick, Moike.
Mike—She is that.
Pat—Is it dangerous she is?
Mike—Divil a bit. She's too wake to be dangerous anny more!

* * *

A teacher in one of the Topeka schools, read at a recent teacher's meeting from a collection of quaint examination answers that she had been gathering for some years.

The gems were:

"A blizzard is the inside of a hen."

"The equator is a menagerie lion running round the earth."

"Oxygen is a thing that has eight sides."

"The cuckoo never lays its own eggs."

"A mosquito is a child of black and white parents."

* * *

A traveler from a distant country came to Victoria in the season of plagues, of rains and sessions. Among the strange sights he beheld was a man who progressed by walking backward; and, turning to a native, the traveler begged him to explain this strange phenomenon.

"That locomotively reversed personage," replied the courteous informer, "is a legislator. He walks backward because the god he worships is precedent; and he is ever under the illusion that he is backing out of his deity's presence."

"How interesting!" exclaimed the traveler. "But do all your legislators walk backwards?"

"No," said the native, "not all. Many of them progress sidewise like a crab."

"But why, pray—why?"

"In order to sidestep issues, of course," responded the native, patiently.

"Then whatever gets done in this remarkable country?" cried the traveler.

The native looked pityingly upon him. "The people, of course," he said.

* * *

"Pardon my ignorance," said Mrs. H—— to the captain of the boat, "but how do you manage to find your way across this pathless lake?"

"By means of the compass, madam," answered the captain. "The needle invariably points to the north."

"But," queried Mrs. H——, "suppose you wish to go south?"

* * *

Among the attendants at the funeral of a lawyer who, though an agnostic, had led a singularly upright life, was a prominent Philadelphian who arrived just after the minister had begun his sermon.

"What part of the services have they reached?" he asked an old Quaker.

"Just opened for the defense," was the reply.

Johnny was given to gross exaggeration and had been severely reprimanded by his mother, who told him that it amounted to the same thing as lying and that she would whip him the next time he was guilty. About five minutes later he came rushing into the house with the news that an immense yellow lion had chased him and almost eaten him up. Upon investigation the lion was found to be a very small yellow dog, and application of the slipper followed.

"Now," said mamma, when it was over, "I hope that will be a lesson to you. But before you go out again I want you to go to your room and tell God how sorry you are for having told stories and ask Him to forgive you."

Johnny disappeared upstairs, to return almost immediately, much relieved.

"Well, has God forgiven you already?" said his mother.

"Sure," said Johnny. "Just as soon as I started to tell Him He said: 'Oh that's all right Johnny. You couldn't help it. The first time I saw that dog I thought it was a lion myself.'"

* * *

A young New York broker of convivial habits fell in with an old school friend who had gone on the road.

"Whenever you're in town come up and bunk with me," he urged his friend as they separated. "No matter what old time it is. If I'm not there just go ahead and make yourself at home. I'll be sure to turn up before daybreak."

Soon after this the salesman arrived in town about midnight, and, remembering his friend's invitation sought out his boarding house. There was only a dim light flickering in the hall, but he gave the bell a manful pull. Presently he found himself face to face with a landlady of grim and terrible aspect.

"Does Mr. Smith live here?" he faltered.

"He does," snapped the landlady. "You can bring him right in!"

* * *

"Did you hear about that man who died the other day and left all he had to the orphanage?"

"No. How much did he leave?"

"Twelve children."

* * *

An eminent lecturer, self-made and proud of it, was addressing a young people's meeting.

"My dear young people," he began, "let me refer to the humble auspices under which I made my start in life. Without a dollar in my pocket and with no worldly possessions of consequence, my indomitable nature and an inborn determination to utilize to the fullest advantages my abilities constituted my assets. But even with this modest beginning, what do you suppose was the very first thing I sought—that which, at the very outset of my career, I strove most earnestly to attain?

Enthusiastic juvenile chorus:

"Milk."

ELECTRICAL DEFINITIONS

Below are defined a few of the most common electrical terms. They are reprinted from month to month and will be of assistance in understanding the magazine text

Accumulator.—See secondary battery.

Alternating Current.—That form of electric current the direction of flow of which reverses a given number of times per second.

Ammeter.—An instrument for measuring electric current.

Ampere.—Unit of current. It is the quantity of electricity which will flow through a resistance of one ohm under a potential of one volt. The international ampere is the current which, under specified conditions, will deposit .001118 gram of silver per second when passed through a solution of nitrate of silver in water.

Ampere Hour.—Quantity of electricity passed by a current of one ampere flowing for one hour.

Anode.—The positive terminal in a broken metallic circuit; the terminal connected to the carbon plate of a battery.

Armature.—That part of a dynamo or motor which carries the wires that are rotated in the magnetic field.

Brush.—The collector on a dynamo or motor which slides over the commutator or collector rings.

Bus Bars.—The heavy copper bars to which dynamo leads are connected and to which the outgoing lines, measuring instruments, etc., are connected.

Buzzer.—An electric alarm similar to an electric bell, except that the vibrating member makes a buzzing sound instead of ringing a bell.

Candle Power.—Amount of light given off by a standard candle. The legal English and standard American candle is a sperm candle burning two grains a minute.

Capacity, Electric.—Relative ability of a conductor or system to retain an electric charge.

Charge.—The quantity of electricity present on the surface of a body or conductor.

Choking Coil.—Coil of high self-inductance which retards the flow of alternating current. See self-inductance.

Circuit.—Conducting path for electric current.

Circuit-breaker.—Apparatus for automatically opening a circuit.

Collector Rings.—The copper rings on an alternating current dynamo or motor which are connected to the armature wires and over which the brushes slide.

Commutator.—A device on a dynamo shaft for gathering the current from the various coils of the armature and sending it out over the line as direct current. On a motor it takes current from the line and passes it on to the armature coils.

Condenser.—Apparatus for storing up electrostatic charges.

Cut-out.—Appliance for removing any apparatus from a circuit.

Cycle.—Full period of alternation of an alternating current circuit.

Dielectric.—A non-conductor.

Dimmer.—Resistance device for regulating the intensity of illumination of electric incandescent lamps. Used largely in theaters.

Direct Current.—Current flowing continuously in one direction.

Dry Battery.—A form of open circuit battery in which the solutions are made practically solid by addition of glue jelly, gelatinous silica, etc.

Electrode.—Terminal of an open electric circuit.

Electromotive Force.—Potential difference causing current to flow.

Electrolysis.—Separation of a chemical compound into its elements by the action of the electric current.

Electromagnet.—A mass of iron which is magnetized by passage of current through a coil of wire wound around the mass but insulated therefrom.

Farad.—Unit of electric capacity.

Feeder.—A copper lead from a central station to some center of distribution.

Field of Force.—The space in the neighborhood of an attracting or repelling mass such as a magnet or a wire carrying current.

Fuse.—A short piece of conducting material of low melting point which is inserted in a circuit and which will melt and open the circuit when the current reaches a certain value.

Generator.—A dynamo.

Inductance.—The property of an electric circuit by virtue of which lines of force are developed around it.

Insulator.—Any substance impervious to the passage of electricity.

Kilowatt.—1,000 watts. (See watt.)

Kilowatt-hour.—One thousand watt hours.

Leyden Jar.—Form of static condenser which will store up static electricity.

Lightning Arrester.—Device which will permit the high-voltage lightning current to pass to earth, but will not allow the low voltage current of the line to escape.

Motor-dynamo.—Motor and dynamo on the same shaft, for changing alternating current to direct and vice versa, or changing current of high voltage and low current strength to current of low voltage and high current strength and vice versa.

Multiple.—Term expressing the connection of several pieces of electric apparatus in parallel with each other.

Neutral Wire.—Central wire in a three-wire distribution system.

Ohm.—The unit of resistance. It is arbitrarily taken as the resistance of a column of mercury one square millimeter in cross sectional area and 106 centimeters in height.

Parallel Circuits.—Two or more conductors starting at a common point and ending at another common point.

Polarization.—The depriving of a voltaic cell of its proper electromotive force

Potential.—Voltage.

Resistance.—The quality of an electrical conductor by virtue of which it opposes the passage of an electric current. The unit of resistance is the ohm.

Rheostat.—Resistance device for regulating the strength of current.

Rotary Converter.—Machine for changing high-potential current to low potential or vice versa.

Secondary Battery.—A battery whose positive and negative electrodes are deposited by current from a separate source of electricity.

Self-inductance.—Tendency of current flowing in a single wire wound in the form of a spiral to react upon itself and produce a retarding effect similar to inertia in matter.

Series.—Arranged in succession, as opposed to parallel or multiple arrangement.

Series Motor.—Motor whose field windings are in series with the armature.

Shunt.—A by-path in a circuit which is in parallel with the main circuit.

Shunt Motor.—Motor whose field windings are in parallel or shunt with the armature.

Solenoid.—An electrical conductor wound in a spiral and forming a tube.

Spark-gap.—Open space between the two electrodes of a spark coil or resonator.

Storage Battery.—See secondary Battery

Thermostat.—Instrument which, when heated, closes an electric circuit.

Transformer.—A device for stepping-up or stepping-down alternating current from low to high or high to low voltage, respectively.

Volt.—Unit of electromotive force or potential. It is the electromotive force which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

Volt Meter.—Instrument for measuring voltage.

Watt.—Unit representing the rate of work of electrical energy. It is the rate of work of one ampere flowing under a potential of one volt. Seven hundred and forty-six watts represent one electrical horse power.

Watt-hour.—Electrical unit of work. Represents work done by one watt expended for one hour.

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FOR SALE—Chicago X-Ray & Coil Co., $200.00, 12-inch coil with condenser, $25.00; interrupter both in mahogany cases; a DeForrest Transmitter value $100.00 and one high tension key. Part of the DeForrest Station at Escanaba, Mich., $150.00 takes the lot. W. M. Orrell, 114 W. Water, Kalamazoo, Mich.

WE HAVE THE HANDSOMEST ELECTROLYTIC DETECTOR in the United States. Price $1.50. Everything in wireless, static machines, $3.75. 2-S inch plates 3 inch spark, Work in wet weather. Plates of any size furnished coated with our wonderful wet weather enamel. Stamp for catalogue. Hertzian Elec. Co., 1924 Flatbush Ave., Brooklyn, N. Y.

CLASSIFIED ADVERTISING

(CONTINUED)

WIRELESS

WIRELESS SPECIAL FOR OCTOBER—Material for a 2-in. spark coil. Norway iron wire core 10x1½. No. 14 D. C. C. wire for two layers of primary. One hard rolled fiber insulating tube. 3 lbs. No. 34 S. C. C. wire for secondary. 4000 sq. inches tin foil. Magnetic interrupter with heavy platium contacts. Brass spark gap with posts, ready to mount. 2 binding posts. Form for winding secondary sections, and complete instructions for winding and assembling. Price $7.35. Send stamp for catalogue of other wireless supplies. O. S. Dawson. 156 Wabash Ave., Chicago, Ill.

SEND 25 CENTS COIN, and ask any questions about construction and operation of wireless. Answers by experienced builder and operator of wireless stations. We make transformers for wireless. A. L. Overstreet, 608 Austin St., Waco, Texas.

WIRELESS EXPERIMENTERS—A new commercial electrolytic detector—Glass-cup—fine t adjustment. Price complete $1.50. Mail 12 cts. Send 2 cent stamp for catalogue and circulars illustrating our large assortment of Wireless Instruments and Novelties. American Wireless Instrument & Novelty Co., 96 Warren St. New York.

JUST OUT. Best work on the subject ever published. "Operators Wireless Telegraph and Telephone Handbook," by Laughter. A storehouse of up-to-date authentic information. --- pages. Illustrated. Money back if not all we claim for it. Price $1.00 postpaid. Free for two paid yearly subscriptions to Popular Electricity. Popular Electricity Book Department. Monadnock Block, Chicago.

1.000 OHM WIRELESS RECEIVERS $1.75. Very sensitive and absolutely reliable. New Wireless Detector. You want to know about both. Send stamp for descriptive circulars. Alden Wireless Co., Campello, Mass.

WIRELESS OPERATORS AND EXPERIMENTERS —You should have a copy of the "Story of Wireless Telegraphy" by A. T. Storey, price $1.00 postpaid; or send $1.50 for the book and a year's subscription to Popular Electricity. Don't miss this chance. Popular Electricity Publishing Co., Monadnock Block, Chicago.

WIRELESS EXPERIMENTERS—Join our Wireless Club. No fees. Handsome club button free to members. Send for application blank. Secretary Popular Electricity Wireless Club. Monadnock Block, Chicago.

WIRELESS EXPERIMENTERS. 1200 OHM receivers, each $3.00. Wound with copper wire and very sensitive. First 25 sold will be fitted with nickel plated headband. W. C. Getz. 345 N. Charles St., Baltimore, Md.

SPECIAL PRICES—1.000 ohm wireless receiver, double pole, special diaphragm. $1.75. Leather-covered headband, single 60c; double, $1.00. "Sealed in Point" electrolytic detector $2.00. "Eclipse" double slide tuning coil $3.00. Sending helix, 450 meters, $2.75. "National" receiving condenser, 30c. Wireless Telephone transmitter, $1.25. Waterhouse Bros., Bourne Mass.

THE NEW SILICON DETECTOR will increase your receiving radius 500 per cent. Only type sold to experimenters authorized by owners of Silicon patents. Infringers prosecuted! Send for special price list. W. C. Getz. 345 N. Charles St., Baltimore Md.

WIRELESS TELEGRAPHY. Complete instructions, with diagrams, for making 1 inch coil, two types of receiver, and all other instruments necessary for a complete wireless sending and receiving station. Price, 25 cts. (coin). Box 519. Lima. Ohio.

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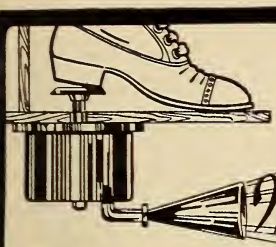
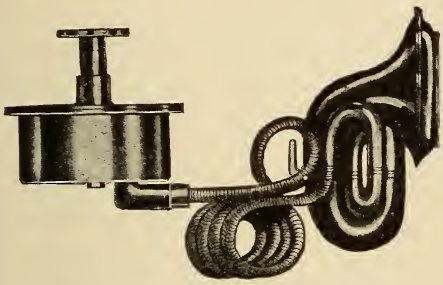


Wordingham Foot Horn

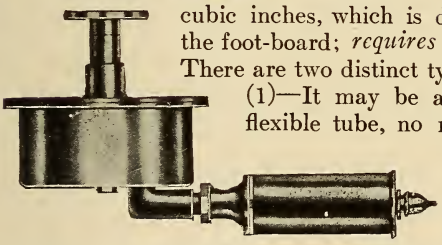
Increase Your Honk 300%



Use it with the Regulation Auto-Horn

The Wordingham Foot Horn is the very latest departure in Auto Signals and can be operated by the heel or toe of the driver *independent of the engine*, leaving both hands free.

Not being operated by the engine exhaust the metal is not corroded by gas and the time and expense of installation is insignificant.



Or Apply the Beautiful Two-Toned Whistle

An air dash pot, all brass, with a capacity of 27 cubic inches, which is dust, water and frost proof. Attached underneath the foot-board; *requires but five square inches.*

There are two distinct types:

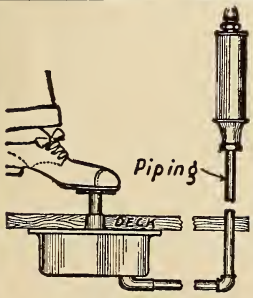
(1)—It may be applied to the ordinary auto horn with the usual flexible tube, no more bulbs to crack, leak and tear, or be at the mercy of the mischievous boy.

Price $7.50.

(2)—Or it is furnished complete with a beautiful two-toned whistle.

Price $9.00.

These advantages of indestructibility, simplicity, tone variety and foot operation can be secured at a cost less than that of the ordinary horn. Let us send you full particulars. Sent prepaid upon receipt of price or express C. O. D.



THE WORDY WHISTLE FOR MOTOR BOATS

A FOOT operated all brass two tone whistle. The Wordy whistle consists of an air dash pot with a capacity of 27 cubic inches of air. It is self-contained and requires but 5 square inches below the deck. The whistle can be placed anywhere in the boat, wherever most convenient and connected to the dash post below the deck with standard ½ inch pipe connections. It operates with the foot independent of the engine, this is positively the latest device on the market and is fully guaranteed. It is dust, water and frost proof and is vastly superior to any exhaust or battery whistle. **Price $9.00 complete.** Sent prepaid upon receipt of price or express C.O.D.

WORDINGHAM MFG. CO., 209 Grand Avenue, MILWAUKEE, WIS.

Railroad Lands Very Cheap

We must Quickly Build up Population along the W. & C. Railroad in New Reservation Just Thrown Open. Free Transportation to Investors and Settlers

WE say that a man of average intelligence, even without previous experience, can make 10 acres of our Washington & Choctaw Railroad lands yield an income of $5,000 a year.

It is up to us to prove it.

And we are prepared to do so.

In the first place we have the land—nearly 100,000 acres in Alabama's most productive area, in Washington County near Yellow Pine.

Then we have the railroad facilities—the Washington & Choctaw Railroad runs up the middle of the tract, with the Mobile & Ohio on the west and the Tombigbee Valley Railroad on the east. Half the land is within one and one-half miles of railroad.

Ours is the only big crop land now offered that is located near to great markets: Chicago is only 29 hours distant and St. Louis but 21 hours away.

HEALTHFUL LOCALITY

This district has national fame as a health resort with an altitude of 300 feet above sea level and only 60 miles from the Gulf Coast.

The United States Marine Hospital Commission reports this section the only part of the country absolutely free from local diseases.

The rainfall is from 55 to 65 inches, the drainage perfect, with no swamps, and irrigation never necessary. The summers are exquisitely beautiful and seldom so hot as in the north. The winters are mild and balmy, the government weather reports showing that for 33 years the thermometer has never averaged below 45 degrees in coldest months.

Does this sound good to you?—

—And we are prepared to prove it.

You understand that our relations to the homeseeker and investor are different—more personal and intimate than under ordinary conditions.

Here we have a vast tract of land through which the W. & C. Railroad runs, that needs development. No railroad can make money without settlers along its line. It is settlers we want—even if we do not make a single dollar of profit on the land.

WHY IT IS SO CHEAP?

For almost half a century this elegant land has been dominated by a great lumber company who would not sell and who patroled the land continually to keep people off. Not even the railroad could buy its right of way. They have now taken off the merchantable timber and only a few weeks ago released the land. It is now thrown open for settlement for the first time.

We are offering the land in any size tract from 10 acres up for almost nothing, only $17.50 per acre, and on easy payments, as low as $1.00 a month. We have planned for two new townsites and the early purchasers can get their land right up near these sites.

This is a case where time is more of a factor than money. Be quick to reserve as much of this land as you think you can buy and pay for it on easy monthly installments.

Chances like this are rare—to get good land near railroad, convenient to great markets and in an ideal climate. Fortune awaits you here.

A CHANCE FOR YOU HERE

We don't care how old you are—whether you are man or woman—you ought to secure one of these farms while we offer them for almost nothing.

Hundreds of men and women will buy this land while it can be secured so cheap. Why not you?

Hundreds of northern men and women have already located in the vicinity of our lands—men and women who were formerly clerks, farmers, stenographers, telegraph operators, insurance agents, railway employees, mechanics, laborers, in fact, men and women of nearly every known occupation—old men of 60 years who felt discouraged and hopeless, young men of 21, who had never had any experience in the world; salaried men, who could see nothing in the future but to become oslerized; laboring men who never realized that there was an opportunity to better their conditions.

We say, these men and women who have bought land near us, are free and independent and are today making more money—MUCH MORE MONEY—than they could make in any other way; and they have their own homes and are happy and contented.

SEND FOR OUR FREE BOOK

We will mail you a book free that tells all about the land—tells it honestly and sincerely. We're enthusiastic over the vast possibilities offered here to the man of little means but whose ambition is to make money and better his condition.

Write for our book—and we will also send you a free pass over the W. & C. Railroad, whether you buy or not.

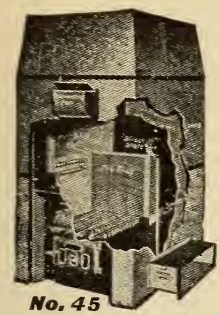
Don't buy land anywhere until you investigate this.

Write today and we will send our book.

ADDRESS

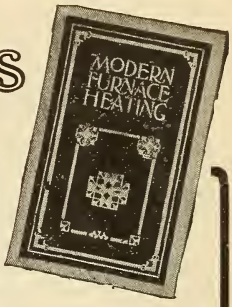
WASHINGTON & CHOCTAW LAND CO.

6146 Times Building, ST. LOUIS, MO.



No. 45
"Leader" Hess
Steel Furnace
Price $49.00
Delivered East of Cmaha and North of Ohio River
Pipes & Registers Extra

60 Winter Days



Free Test at Our Risk and Cost

As manufacturers, directly responsible to you for satisfactory results, we will send you a **Hess Steel Furnace** and complete heating outfit, including pipes, registers, fittings and everything needed, made to fit your measurements, with correct plans and instructions for installing, at **$50 to $100 less** than you can buy from dealers. We deliver the outfit at your station, freight prepaid. You place the purchase price in the hands of your local banker, who will hold the money 60 days while you test the heater.

In case the test is not satisfactory in every way, you may return the goods at our expense and the banker will refund your money.

Don't Pay an Exorbitant Price for a Heating Outfit

We have manufactured heating outfits for 36 years, and can assure you that there is no necessity for paying the exorbitant prices demanded by others in order to have a modern, high-grade furnace and outfit installed in your building.

Send us a rough sketch of any building you wish to heat. Without any charge or obligation on your part, we will have our expert furnace draftsmen prepare a plan which you can easily understand, showing the best way to heat your building, including every detail of the furnace, pipes, registers, etc., in their proper places, with the exact cost to you of the complete equipment. No charge for this.

Write for our free booklets, **"Modern Furnace Heating"** and **"These Bear Witness."** They tell much you should know before ordering your heating equipment. Write now—today—before the usual rush begins.

Installing a Hess Furnace is Easy

By following our simple, clear plans and directions, any man handy with tools can easily install a Hess Furnace and outfit. We furnish all the necessary tools.

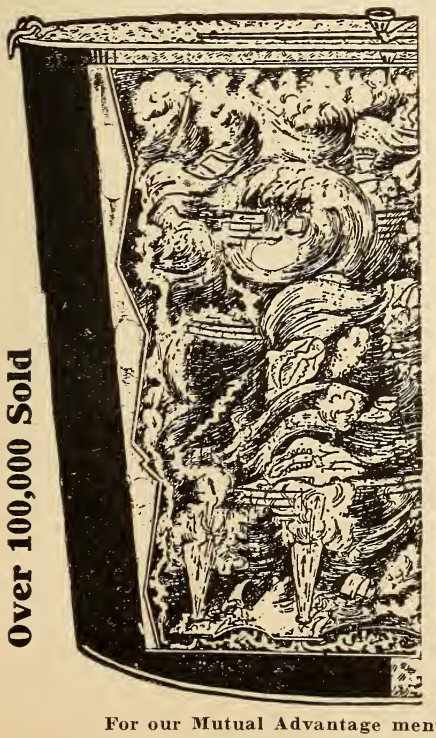
Write Today for Booklets and Estimate. **912 Tacoma Bld.**

Hess Warming and Ventilating Co. **CHICAGO**

New Invention! No More Wash Day!

New Method of Cleaning Clothes

Cleans Family Wash in 30 to 50 Minutes —Woman's Hardest Work Made Easy— No Rubbing, No Motors, No Chemicals



Over 100,000 Sold

Not a Washing Machine Does in one operation the work of Wash Board, Washing Machine and Wash Boiler.

See How Simple, Different, Easy. Put on any stove—add water, then soap, then clothes—*move knob occasionally.* In 5 to 8 minutes first batch clean—next batch same way, same water—in 30 to 50 minutes family wash clean. *No labor, no injury to clothes. Cleans woolens, flannels blankets,* or colored clothes, as well as white goods, finest laces, curtains, bed clothes. *Saves times, fuel, labor.*

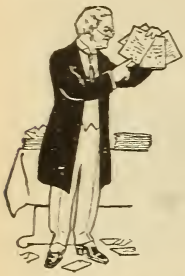
EASY WAY in 30 to 50 minutes cleans washing which before took entire day. All metal, strong, durable, sanitary, light in weight. Easily used, cleaned, handled—always ready. Child or weakly woman can use it. Saves washday drudgery.

Users Praise the "Easy Way" J. McGee, Tenn., writes:—"One young lady cleaned *day's washing in one hour* with Easy Way—another in 45 *minutes.*" Mrs. T. Bullen, Canada, writes:—"I washed *bedding, heavy quilts, curtains, etc., without rubbing.*" Lauretta Mitchell, O., writes:—"Done a *big washing in 45 minutes—sold 3 already.*" A. D. Poppleton, N. Y.:—"Gives perfect satisfaction. Washed bed quilts, *greasy overalls* and fine clothes. Greatest thing on earth." F. E. Post, Pa., writes:—**"Two weeks washing in 45 minutes.** Clothes cleaned *without rubbing.*" J. H. Barrett, Ark., after ordering 38 Easy Ways, says:—"You have the grandest invention I ever heard of." J. W. Myers, Ga., says: "Find check for 12 Easy Ways. Greatest invention to womanhood, forever abolishing miserable wash day. *Sells Itself.*"

Agents Getting Rich *R. O. Cowan, N. Y., placed 13 in 6 hours*—(profit $39.00). Mrs. J. Brown sold 10 in 3 days—(profit $30.00). K. J. Blevins, O., writers:—"*Made 7 calls, sold 5 one day.*"—(profit $15.00). R. H. Latimore, Pa., writes—"Sold 4 this morning. *Never yet turned down.*" A. G. Witt, Pa., "Received Easy Way yesterday; sold 4 to-day—not out for orders." Mrs. Gerrish, Mont., ordered sample, then 1 dozen, then 100—(profit over $300.00). *Just made one shiptment* 1000 *Easy Ways* to Russian Agent. N. Boucher, Mass., orders 75 more, says: "Everybody wants one, *best business I ever had.*" A. S. Verrett, La., sold 8 in 1 day—(profit $24.00.)

FREE SAMPLE TO AGENTS We want managers, agents, men or women, home or traveling, all or part time, to show, take orders and appoint agents. **Easy Way new article,** not worked to death. Best seller out. Every family wants one. People glad to see it demonstrated; buy without being asked, and throw away costly washing machines to use it. **Only two sales a day means $36 00 a week profit. Price only $6 00** ready for use. Sent anywhere. Not sold in stores. *Order one for your own use.* **Your money refunded if not satisfactory.** *Send for free sample offer special, agents' proposition, etc.* **Costs nothing to investigate.** Send name and address anyway for full description.

Harrison Mfg. Co., 145 Harrison Bldg., Cincinnati, O.



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DYKE'S COURSE OF

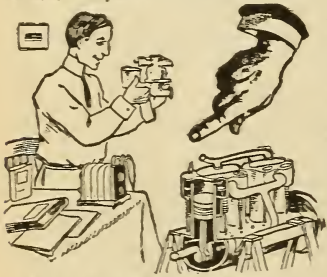
Automobile Instruction

A NEW METHOD WITH WORKING MODELS

Listen! We have *Testimonial Letters* from each and every customer. Study during spare time—Dyke's Course is now only $10 and you would never miss the amount. The Automobile and Gasoline Engine profession is the best profession, and there is a big demand for help in this line.

IF YOU OWN an auto, or launch, or in any way connected or interested in gasoline engines then this course will be of great benefit to you. If you wish to learn the trade this is your opportunity.

DYKE'S COURSE is the only course in the world which can successfully be taught by mail. We use wonderfully clever **Working Models** (made in Europe) of the **Gasoline Engine** and **Magneto** and **Carburetor** that actually work, and they picture the meaning while you study our interesting Instruction Pamphlets.



JUST IMAGINE, having in your room an engine cut in half and with each and every part lettered and numbered, also a Carburetor and Magneto lying on your study table while you study our interesting course—that's practically what we give you in our **working models.** You will play with these models like a boy with a toy and the more you play the clearer the subject will be to you.

IN ADDITION we give 24 lessons which are so interesting you will finish them all—they are illustrated with 34 large clear charts.

WE TEACH YOU everything there is to learn about the Automobile and Gasoline Engine such as valve setting, timing ignition, how the cylinders fire, construction of all forms of Magnetos and how to set them, storage batteries and all systems of wiring, and many other important subjects.

ONE CUSTOMER SAYS:

"I've learned more in three weeks study of your Course than during my ten years work around the shop."

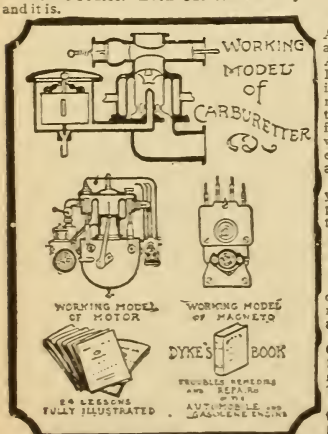
Another customer who knew nothing about the Auto or Gasoline Engine says he can now run any car and set valves, etc.

OUR LIBERAL OFFER of inspection is proof of our claims, get our fine pamphlet and testimonials.

AUTOMOBILE OWNERS will save the cost the first month.

Automobile Engineering is a profitable trade to learn. Our Course qualifies you—write today.

NOTE We are considering the advisability of raising the price on this wonderful Course. Even our students say it is worth a great deal more and it is.


WORKING MODEL of CARBURETTER
WORKING MODEL OF MOTOR
WORKING MODEL OF MAGNETO
DYKE'S BOOK
TROUBLES REMEDIES AND REPAIRS OF THE AUTOMOBILE AND GASOLENE ENGINE
24 LESSONS FULLY ILLUSTRATED

MR. DYKE was the first Auto Supply man in America and built the fifth successful Automobile in this country. His experience is embodied in this course. Mr. Dyke made a special trip to Europe to secure additional matter for this great Course. The working models were designed and are made in Europe by a leading mechanical artist.

NO MATTER how much you would pay you could not possibly get a course equal to this one,

Here They Are:

The working models of our Gasoline Engine, Magneto and Carburetor—they **actually work.**

The really feature of our Course, however, are our **24 simple illustrated lessons.** We also include a Text book.

It is great—all our customers say so—not one, but all.

FREE THIS AUTO BUTTON AND INSTRUCTIVE PAMPLET SEND FOR IT TODAY

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DYKE'S Corso' School Motoring
1300 Bk. Commerce Bldg., ... St. Louis

The Rittenhouse Hotel

Twenty-second and Chestnut Streets
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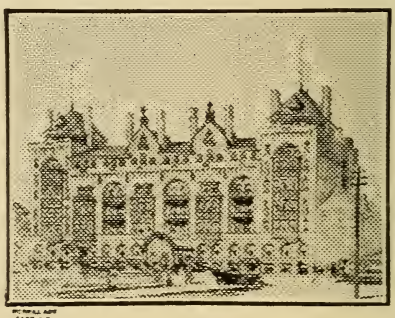

One of the most exclusive Hotels in PHILADELPHIA. Within five minutes walk of the BUSINESS CENTRE, RAILROAD STATIONS, the SHOPPING DISTRICTS and THEATRES.

One half block from the College of PHYSICIANS and SURGEONS.

A home-like Hotel catering to transient and permanent guests. Special attention to ladies traveling alone.

Conducted on the AMERICAN and EUROPEAN PLAN. Cuisine and service of the highest standard. Distilled water.

Unique cafe, attractive parlors, spacious exchange and ladies' reading room.

European $1.50 per day and up
American $4.00 per day and up

R. VAN GILDER, Mgr.

Smaller Central Stations Need Our Services

What has been accomplished in selling more current in Chicago, New York, Buffalo and Cleveland, by Central Station advertising in the newspapers, can be accomplished in smaller cities with proportionate effect.

We have an exceptional proposition to submit to any Central Station open to conviction. Our proposition will show how you can test the business-getting value of our advertising service at a cost ridiculously low.

The service will be equal to that which we have rendered the Commonwealth Edison Co., the Buffalo General Electric Co., the Cleveland Illuminating Co., and the New York Edison Co.

Ask for particulars.

Wm. D. McJunkin Advertising Agency

167 Dearborn Street, Chicago

$20 to $35 and EXPENSES WEEKLY

At home or traveling, all or spare time. Easily learned.

GET MONEY—I DID—GOT $301.27

worth of plating in two weeks, writes M. L. Smith, of Pa. (used small outfit.)

George P. Crawford writes:—"Made $7.00 a day." J. J. S. Mills, a farmer, writes:—"Can easily make $5.00 a day plating." Thos. Parker, school teacher, 21 years, writes:—"I made $9.80 profit one day, $9.35 another." Others making money—you can do the same.

Costs Nothing to Investigate.

WRITE TODAY

LET US START YOU in the Gold, Silver, Nickel and Metal Plating business. **$5.00 to $15.00 a day** can be made doing plating with **Prof. Gray's new line of guaranteed Plating Outfits.** Unequalled for plating watches, jewelry, tableware, bicycles, all metal goods. Heavy plate. **Warranted. No experience required.** We do plating ourselves. Have years of experience. Use same materials we sell. Materials cost about 10c to do $1.00 worth of plating. Manufacture the only practical outfits, including all tools, lathes, and materials. All sizes complete. Ready for work when received. **Guaranteed. WE TEACH YOU the art, furnish recipes, formula and trade secrets FREE. THE ROYAL, Prof. Gray's New Immersion Process.** Quick. Easy. Latest method. Goods dipped in melted metal, taken out instantly with fine, brilliant, beautiful plate, ready to deliver. Thick plate every time. **Guaranteed from 5 to 10 years. A boy plates from 100 to 200 pieces tableware daily, $10 to $30 worth of goods. No polishing, grinding or electricity necessary. ☞DEMAND FOR PLATING IS ENORMOUS.** Every family, hotel and restaurant have goods plated instead of buying new. It's cheaper and better. Every store, jeweler, shop, factory, has goods needing plating. Agents have all the work they can do. People bring it. You can hire boys cheap to do your plating, the same as we, and solicitors to gather work for a small per cent. Replating is honest and legitimate. Customers delighted. **WE ARE AN OLD ESTABLISHED FIRM.** Been in business years. Capital, $100,000.00. Know what is required. **Our customers have the benefit of our experience, so that failure is next to impossible. WE ARE RESPONSIBLE and guarantee everything.** Reader, here is a chance of a lifetime to own and boss a business of your own. WE START YOU. **Now is the time to make money.** CALL OR WRITE TODAY. Our new plan. Samples of plating, testimonials and circulars FREE. Don't wait. Send us your address anyway.

GRAY & CO. PLATING WORKS, 54 GRAY BUILDING, CINCINNATI, OHIO

WIRELESS COMMUNICATION

Now is the time to engage in the study of the new art of wireless. The demand for trained wireless operators is growing constantly. The recent government action has increased the demand 100 per cent. Salaries of trained operators range from $15.00 to $40.00 per week.

THE AMERICAN WIRELESS INSTITUTE

is the only universally recognized school in the world for the teaching of this art.

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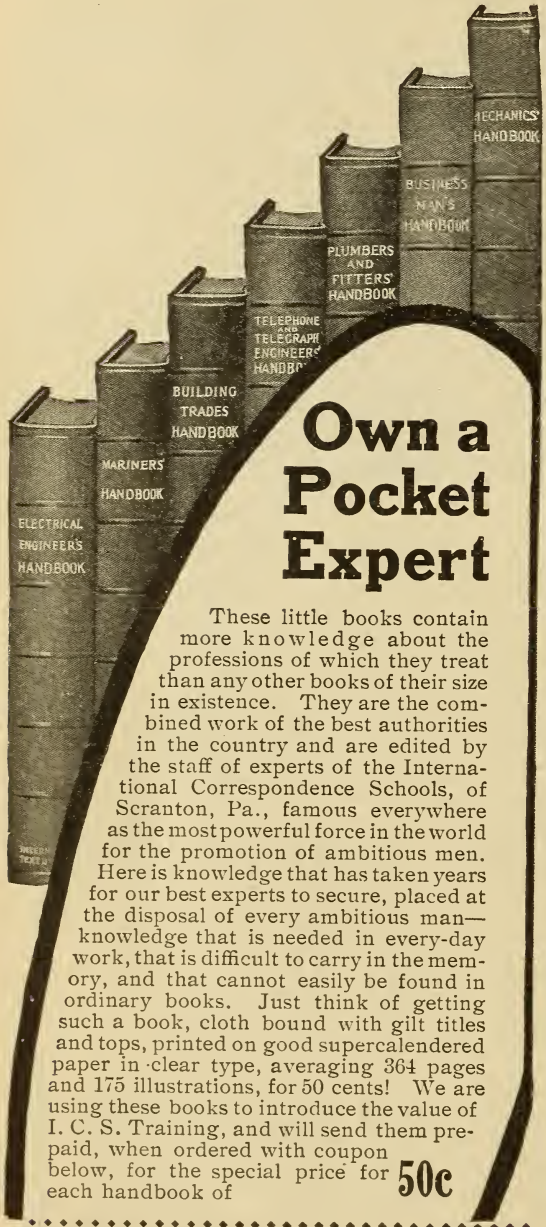

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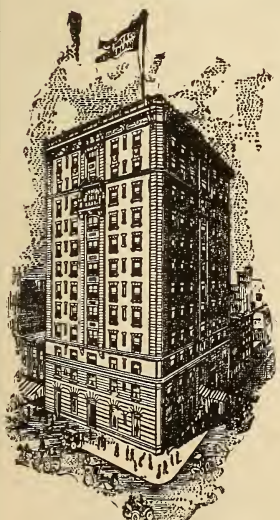

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Among my 35 different brands I have an "in between" smoke called "Old Fashioned Havana Smokers." I want you to be on smoking terms with them, because they are just the thing you want when you *don't* want a big cigar. They are Havana filled—4 in. long—blunt at both ends—made the way the Cuban planter rolls tobacco for his own use—without a binder.

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Send me $2.40 for 100 Morton R. Edwin Panatelas. Smoke as many as you like—smoke them all if you want to, and if you then tell me that you didn't receive more than you expected, I'll return your money and we'll remain friends.

If you want to know who I am and whether or not I run my business on the square, if you have any doubts as to my making good if my cigars don't, just inquire from any bank or commercial agency about me. If you don't like the report you get, keep your cash at home.

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Let us show you our new system of lighting (indirect Illumination) for

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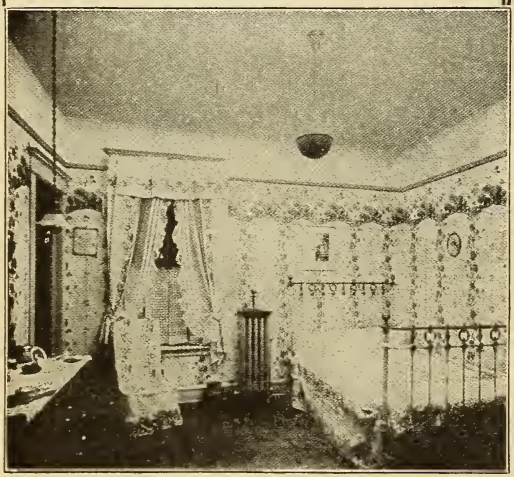

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Those who experience discomfort after a short time under a direct light, suffer no unpleasant effects from an evening's work under the I-COM-FORT. Scientists and oculists have long agreed on the perfection of such a system of lighting but heretofore the cost of maintaining and installing has proven prohibitive. The I-COM-FORT is simple and inexpensive; under a 60 to 100 Watt Tungsten electric lamp is placed a glass reflector with spiral and vertical corrugations over pure silver, giving the most perfect reflecting surface known to science; the light is thus thrown upon the ceiling and is evenly distributed throughout the room with wonderful efficiency, artistic effect and eye comfort.

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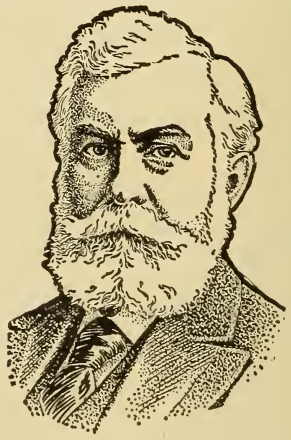

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All notable improvements in electric lighting during the last 30 years *have been introduced* by the General Electric Company.

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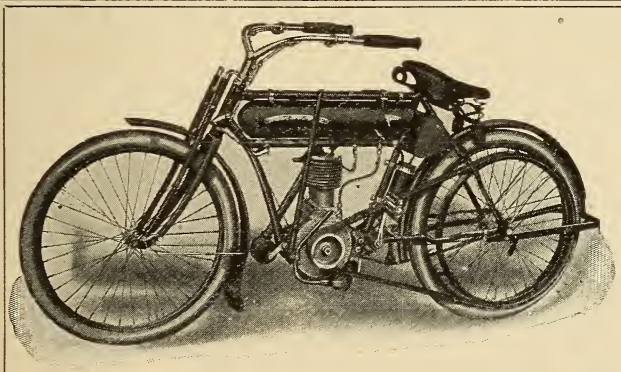

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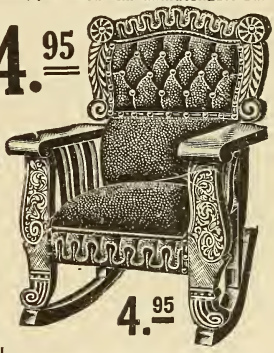

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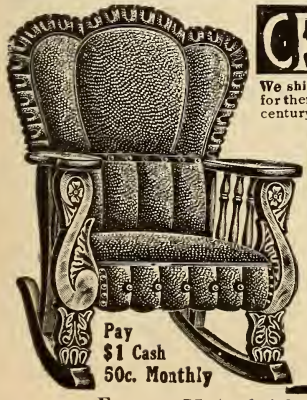

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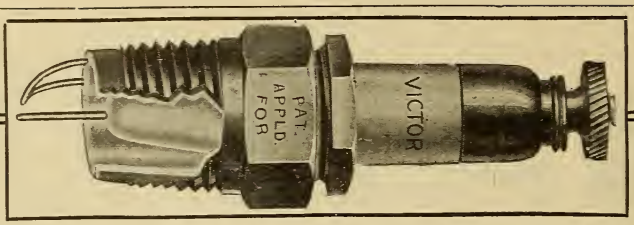

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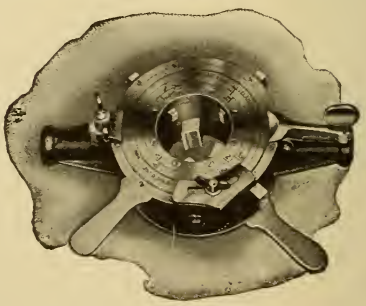

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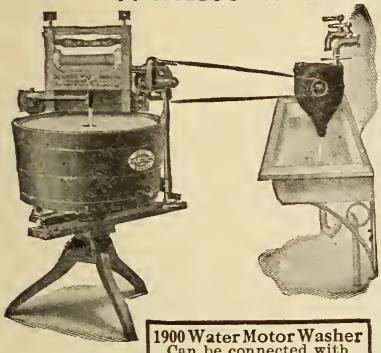

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Can be connected with any water tap instantly

Handles heavy blankets or dainty laces.

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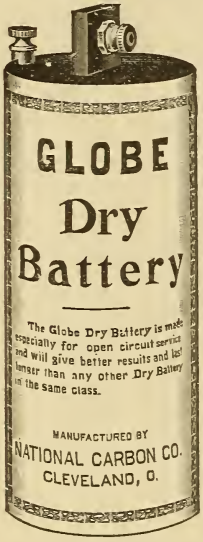
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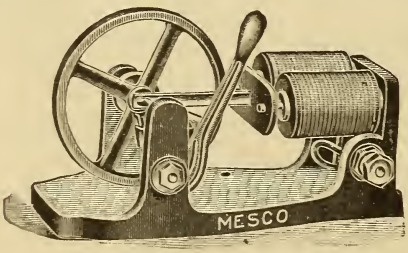

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Trade Word	Catalogue No.	List Price	Postage
Ablicumer	403 K, with tools, each, net	$5.00	25c
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No. 403 K

Genuine leather case, contains a selection of Klein tools such as have been found particularly desirable by Electricians and wire men on switchboard and telephone work. It is of convenient pocket book style, with firm metallic clasp and measures 4x9 inches. It contains the following tools: 1 single blade electrician's knife, 1-5 inch Klein side cutting pliers, 1-5 inch Klein oblique pliers, 1-6 inch Klein long nose side cutting pliers, 1-3 1-2 inch blade screw driver and 1 pair 5-in. N.P. electrician's snips.

NOTE—The pliers are plain black finish, if nickel plated pliers are wanted add 25 cents net, each, for plating. Case furnished either russet or black color. **Send 3c. stamps for 65-page Catalogue.**

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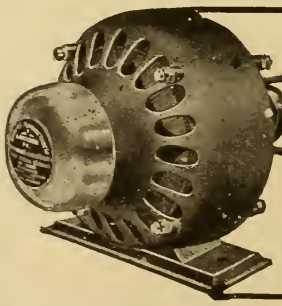

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To heat the iron, simply push the switch plug in. And to cool it, take the plug out.

Putting in and taking out the plug controls the amount of electric current carried into the iron, and regulates the temperature.

Shortly after the plug is inserted the iron is hot. From then on you will not need current more than half the time.

The regular household iron weighs 6 lbs. but you never have to **lift** it—no carrying it from stove to board, and when not in use simply tip it up on the broad end. The stand is attached.

The heat all goes into the ironing. Hence, you iron in perfect comfort. You need no holder. Take it to any room, too; or out onto the porch.

Approved by the National Board of Fire Underwriters

The Hot Point **Automatic** Iron cannot be over-heated. Therefore it cannot possibly start a fire. If you forget to pull out the switch plug the automatic device does it for you. It is controlled by the temperature of the iron; is positive and certain. The **Automatic** Iron simply **cannot** get hot enough to do any damage.

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And the same is true of every electric iron in the world, of whatever name, except only the Hot Point **Automatic.** Where the iron will be used intelligently, the **Standard** will answer every purpose, and there is little fire risk.

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Therefore when you go to your Lighting Company or Dealer ask to see the HOT POINT IRON. If they do not have it, order direct.

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PACIFIC ELECTRIC HEATING CO.

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Send me, charges prepaid, 1 Standard Hot Point Iron, $5.00
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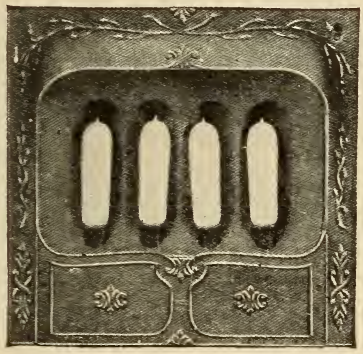

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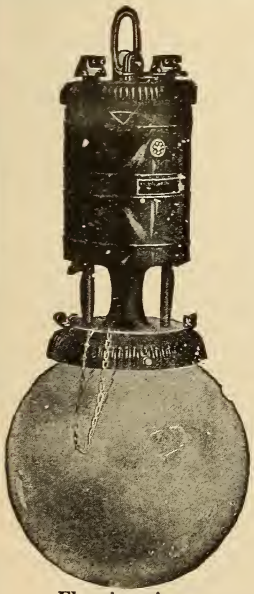

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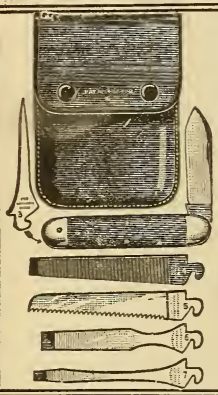

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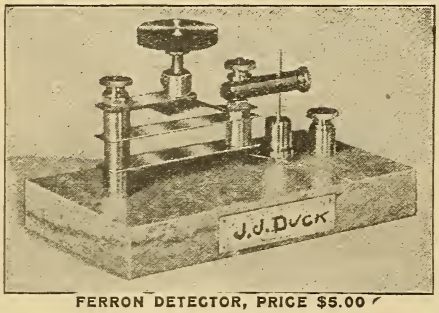

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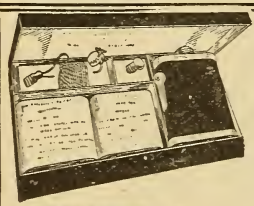

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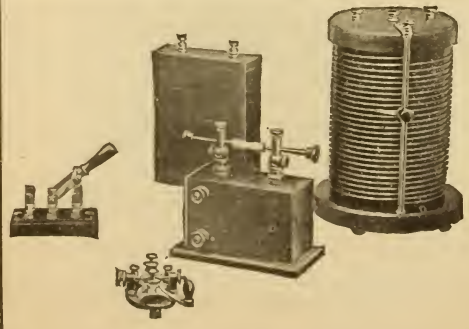

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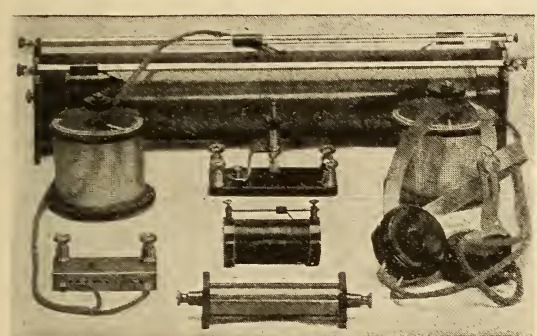

This month we wish to call attention to our "Tri-mount Professional Set," Type C, as shown above.

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2 Adjustable Air Capacities	8.50
Universal Detector Stand	4.50
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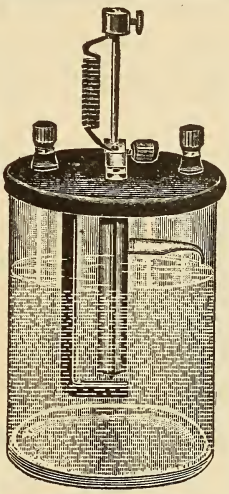

FIG. 2

FIG. 3

THE GERNSBACK ELECTROLYTIC INTERRUPTER

has been declared to be the most efficient interrupter of modern times. This interrupter has been described in the August issue of Popular Electricity, page 245, where particulars may be found. Figure No. 2 shows spark obtained of a 2″ coil on a 6 volt battery. Figure No. 3 of the same coil on 110 volts with the Gernsback interrupter. A **FLAME** one quarter inch thick is obtained such as you never saw before. Efficiency of coil is increased fully 500%. No resistance necessary, hook up the interrupter in series with the coil and 110 volts for operation. Coils from ¼″ up to 12″ spark length are used successfully with the new interrupter. Price complete $2.50. Send two cent stamp for our wonderful 120 page electrical cyclopedia containing immense quantity of information especially **WIRELESS.**

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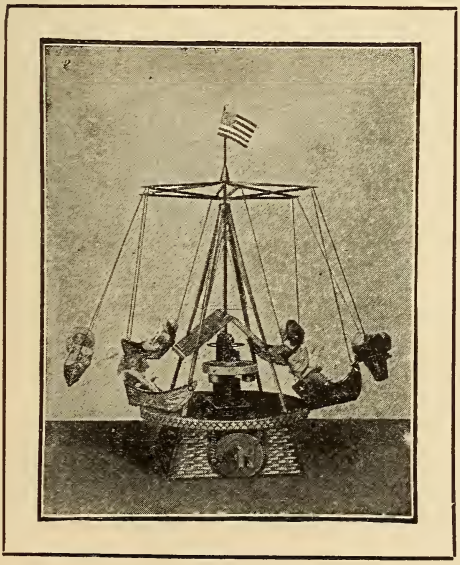

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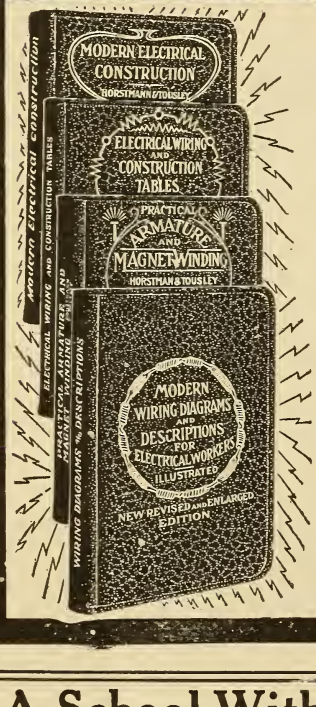
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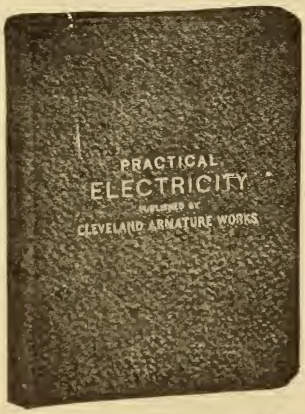

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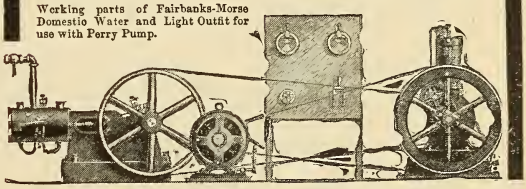

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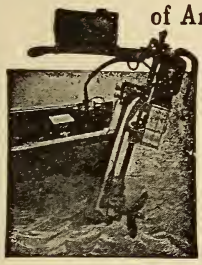

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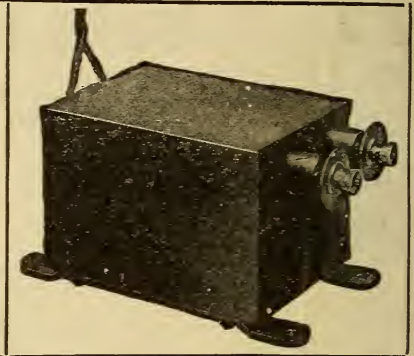

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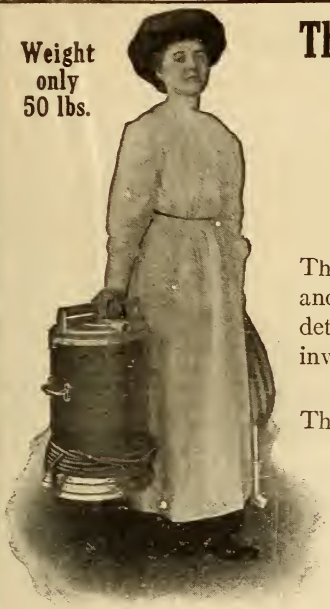

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It has a calculated displacement of 25 to 30 cubic feet free air per minute.

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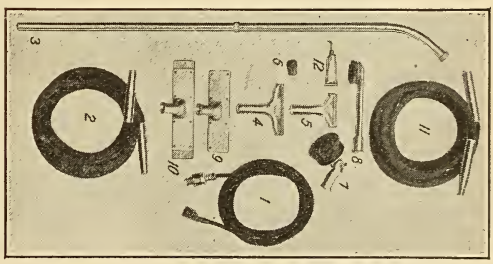

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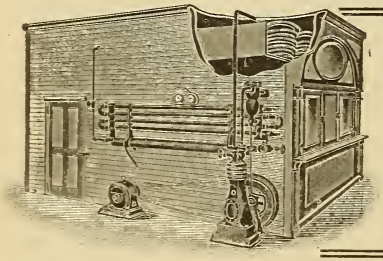

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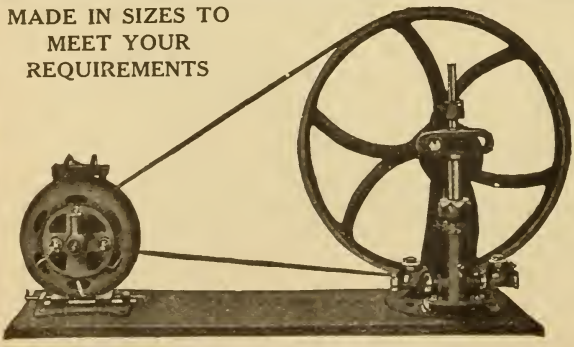

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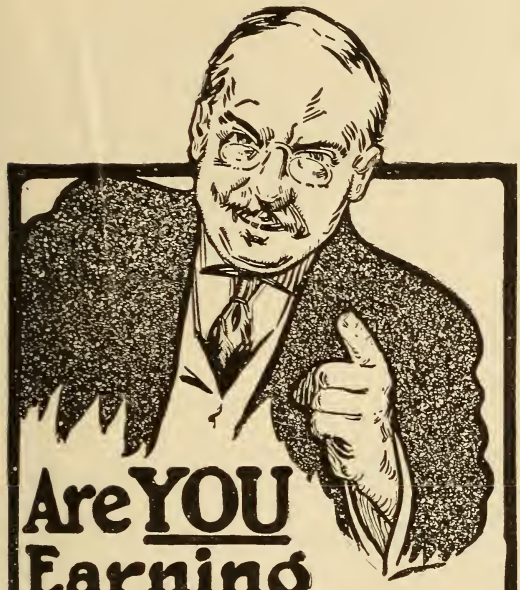

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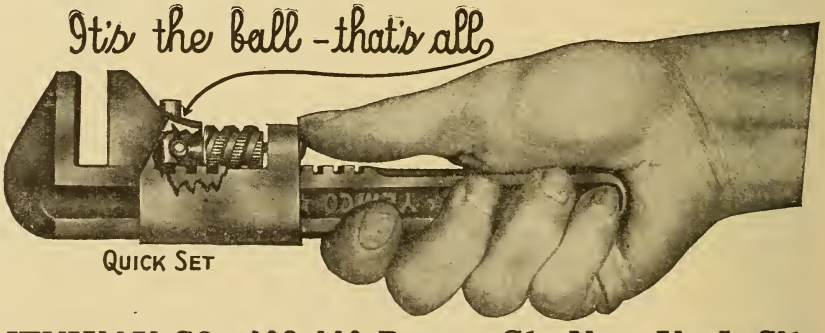

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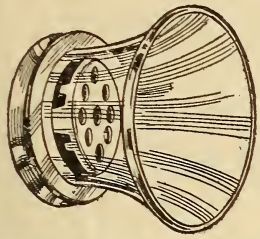

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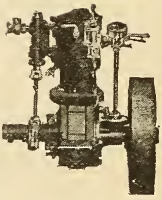

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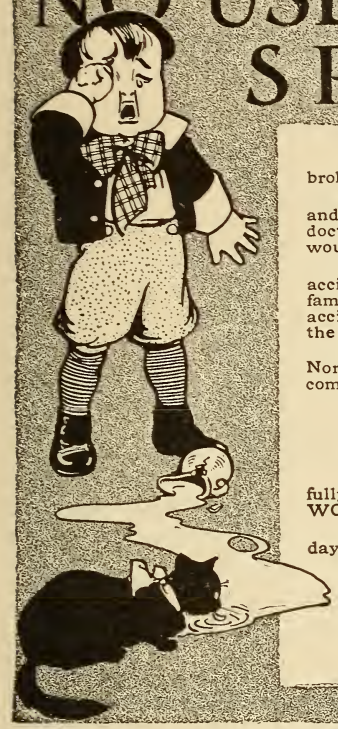

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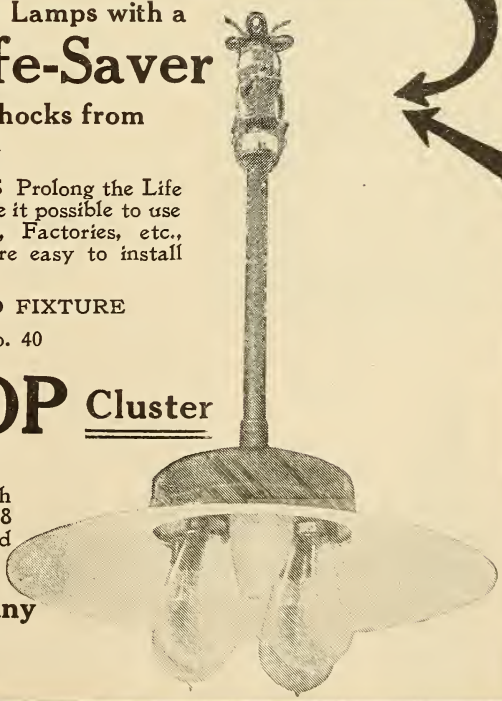

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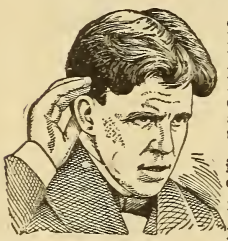

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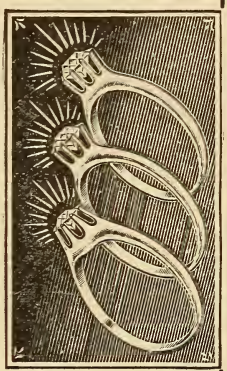

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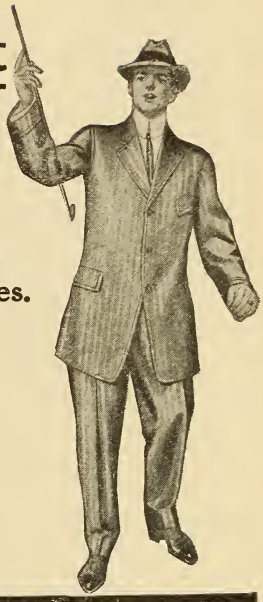

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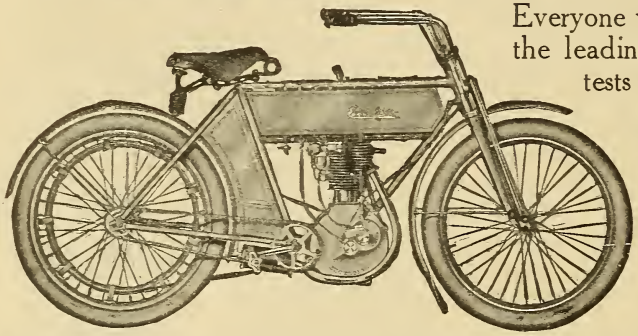

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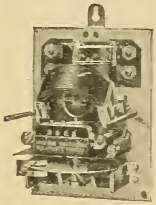

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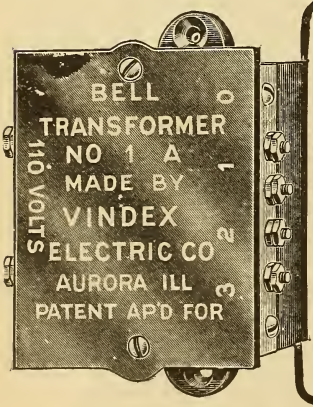

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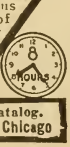

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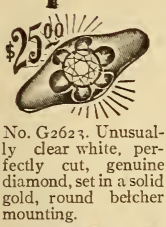

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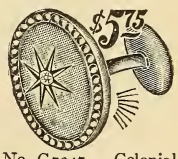

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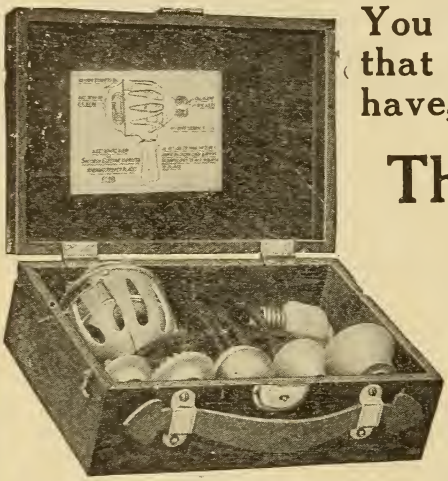

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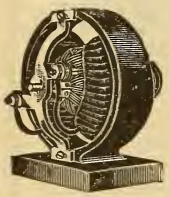

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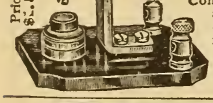

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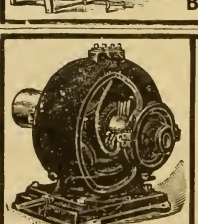

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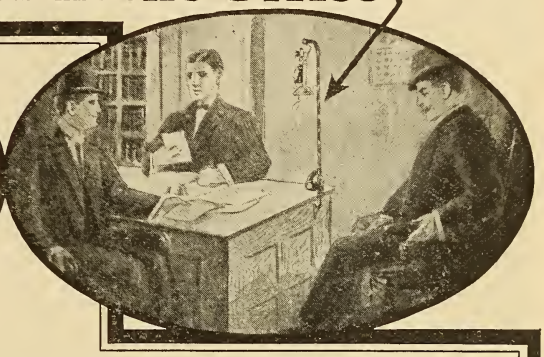

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It is never in the way but always ready for instant use sitting or standing.

It permits you to adjust the telephone to your position.

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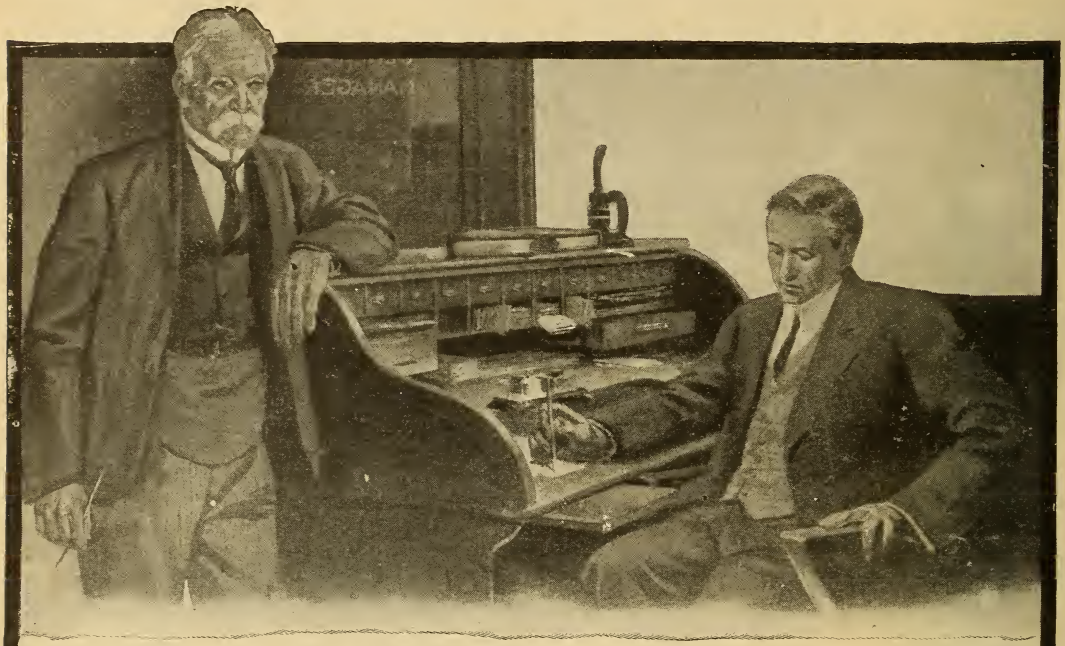

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